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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

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See half-page Advertisement, page 36, Jan. 19.

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EDWIN DELLER,
Academic Registrar.
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Tenders for the Reconstruc-

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Firms wishing to Tender for Boilers, Heating Apparatus, Engines, Dynamos, Laundry Apparatus, Water Softener, and Building new Boiler House, in separate sections, to the plans and specifications prepared by the Guardians' Consulting Engineer, Mr. W. M. BENNY, A.M.I.C.E., are requested to send their names to the Clerk with references to similar recent work carried out by them at other institutions.
Firms are requested in the first instance to examine (by appointment, between Ten a.m. and Three p.m.), at the Guardians' offices, plans showing the proposed extent of the work, after which a set of plans and specifications will be provided to the firms selected to Tender, a deposit of £10 being required which will be returned on receipt of a Tender properly filled in.
Applications to be allowed to Tender must be received not later than 21st February, 1923.
By Order,
F. J. CURTIS,
Clerk to the Guardians.
Union Offices,
St. John's Hill,
Wandsworth, S.W. 18.
1st February, 1923. X 544

TENDERS INVITED.

COUNTY OF LONDON ELECTRIC SUPPLY CO., LTD.

BARKING POWER STATION.

The County of London Electric Supply Co., Ltd., are open to receive

Tenders for the Supply and

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F. C. McQUOWN,
Manager and Secretary.
The County of London
Electric Supply Co., Ltd.,
Moorgate Court,
Moorgate Place, E.C. 2. X 564

THE HIGH COMMISSIONER FOR INDIA is prepared to receive

Tenders for the Supply

of:—
WHEELS AND AXLES for Railway Carriages.
Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 18, Belvedere Road, Lambeth, S.E. 1, and Tenders are to be delivered at that Office not later than Two o'clock p.m. on Tuesday, the 6th March, 1923.
T. RYAN, X 554
Director-General.

CAST-IRON PIPES.

The Directors of the STAFFORDSHIRE POTTERIES WATERWORKS COMPANY invite

Tenders for the Supply of

3130 tons of 24 in. CAST-IRON PIPES.
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The Directors do not bind themselves to accept the lowest or any Tender.
R. C. FRAIN, M.Inst.C.E.,
Engineer.
39, Albion Street, Hanley,
Stoke-on-Trent.
9th February, 1923. X 575

THE SOUTH INDIAN RAILWAY COMPANY, LIMITED,
are prepared to receive

Tenders for the Supply of:—

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Specifications and Forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked: "Tender for Steel Roofing," must be left with the undersigned not later than Twelve Noon on Friday, the 2nd March, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 2s. 6d. for each copy of the Specification.
Copies of the Drawings may be obtained at the Offices of Messrs. ROBERT WHITE & PARTNERS, Consulting Engineers to the Company, 3, Victoria Street, Westminster, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France, S.W. 1.
5th February, 1923. X 566

Re ARC and GENERAL EQUIPMENT Ltd., of Hartham Road, Holloway, N.

Messrs. FULLER, HORSEY, SONS, & CASSELL are instructed to invite

Tenders for the Purchase, in

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BUSINESS AND ASSETS
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(3) The STOCK, STORES, and WORK IN PROGRESS.
(4) The VALUABLE LETTERS PATENT for the manufacture of the car heater and hoisting and winding appliances, together with patterns, drawings, jigs, dies, gauges, &c.
(5) The GOODWILL of the BUSINESS.
The purchaser will have the option of acquiring, on payment of the costs of the assignment, the beneficial interest in the lease of the Holloway Works, which has an unexpired term of seven years, at a rental of £400 per annum, so that he will be in a position either to continue the business in situ or to transfer same to his own works.
Tenders, which must be in the form contained in the particulars of sale, should be delivered under seal to HERBERT TERRAS, Esq., F.C.A., 64, Cross Street, Manchester, by Twelve noon on Monday, February 19th. Immediate possession of the works and other assets of the Company may be had on the purchaser accepting the vendors' title and on payment of the whole of the purchase money.
Particulars, with conditions of sale, may be obtained of Messrs. PHILIP SWANWICK, TERRAS AND CO., Chartered Accountants, 64, Cross Street, Manchester; of Messrs. R. & W. PAGE, Solicitors, Lloyds Bank Buildings, King Street, Manchester; and of Messrs. FULLER, HORSEY & CO., Auctioneers, 11, Billiter Square, London, E.C. 3.
NOTE.—The LEASEHOLD DWELLING HOUSE adjoining the works, No. 37, Hartham Road, Holloway, N. 7, is offered for SALE by TENDER as a separate lot, WITH VACANT POSSESSION. The lease has seven years unexpired at £70 per annum. X 572

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Applications, stating whether married or single, age, birthplace, and giving details of education, training, and experience generally, with particular reference to the items mentioned above, and copies (only) of testimonials, to be lodged with Messrs. C. C. LINDSAY & PEIRCE, MM.Inst.C.E., 180, Hope Street, Glasgow, Agents for the Commissioners (who will give further particulars if requested), not later than Tuesday, 20th February, 1923. X 573

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FOUNDRY. Young, energetic, capable of making high class hydraulic castings and experienced with Moulding Machinery and up-to-date methods.—Address, X 551, Offices of ENGINEERING.

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MANUFACTURING COMPANIES AND SIMILAR CONCERNS.
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18-IN. REFRACTING TELESCOPE FOR THE BRAZILIAN GOVERNMENT.

(*Continued from page* 131.)

THE driving clock of the telescope is of the cross-armed governor type and is shown in Figs. 21 to 30 on Plate XIV. It is fitted with Messrs. Cooke's type of maintaining gear, by which the effective driving power is kept uniform during the several windings-up which have to be performed while long-time exposures of star plates are being made. The wheel and planet motion composing the maintaining gear is shown in Figs. 24, 25 and 27; it is fitted at one end of the clock cord drum. The clock is also provided with a speed-varying device and can thereby be instantly set to make the telescope follow the heavenly bodies at their several speed rates. This is effected by an adjustable lever which raises or lowers the governor spindle and so brings the upper ends of the governor arms into rubbing contact with a fixed friction ring at various positions and speeds of the governor balls. The device is shown in Figs. 24 and 27.

The most perfectly-running instruments in important astronomical observatories being the time clocks, which in many cases are placed where they are practically free from the effect of temperature variations, the perfectly regular running of an astronomical telescope might seem to be attained by driving it from one of these clocks. The periodic swing of a pendulum, however, defeats this object, a governor type pendulum clock giving a regular turning motion being necessary for the drive. The astronomical pendulum clock beating seconds can, however, be used to control the regular running governor clock so that its extremely small speed variations are automatically corrected. This is done by a delicate electric make-and-break contact which is attached to the time clock pendulum, a current being sent every second to a magnet which momentarily lifts a trip lever on the clock and frees or retards a pawl on a ratchet wheel revolving once a second. This wheel has 180 ratchet teeth cut in it, and thus retardation of the telescope driving clock can be effected to $\frac{1}{180}$th of a second, regulation of the clock governor speed being made just barely in excess of the pendulum time, and so enabling the seconds control gear to operate. This electric control is shown in Figs. 24 and 29 on Plate XIV.

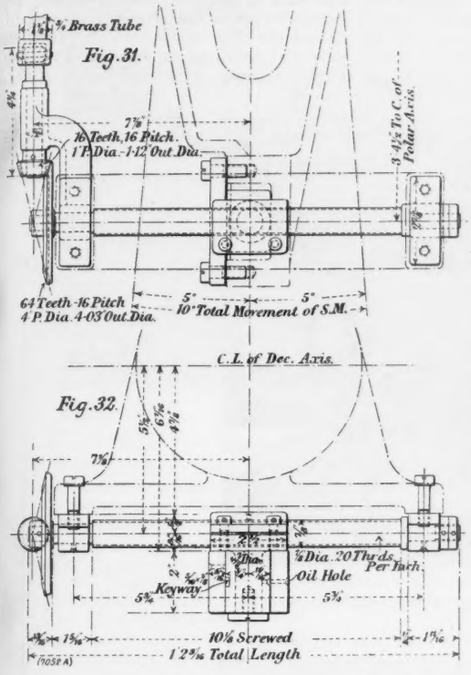


Fig. 31.
⅝ Brass Tube
7⅞
16 Teeth. 16 Pitch. 1 P. Dia. 1·12 Out. Dia.
3 4⅞ To C. of Polar Axis.
64 Teeth. 16 Pitch. 4 P. Dia. 4·03 Out. Dia.
5" 5"
10" Total Movement of S.M.

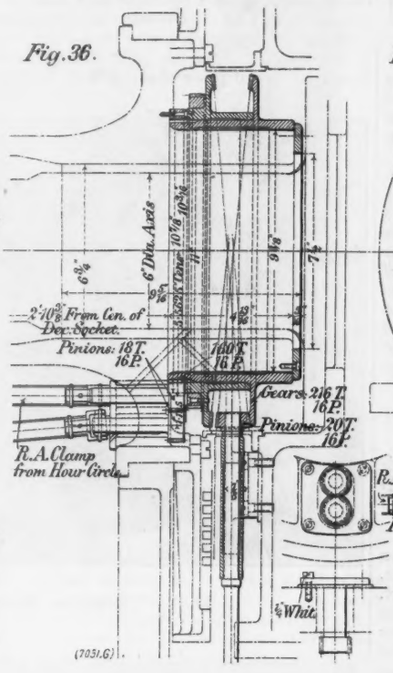
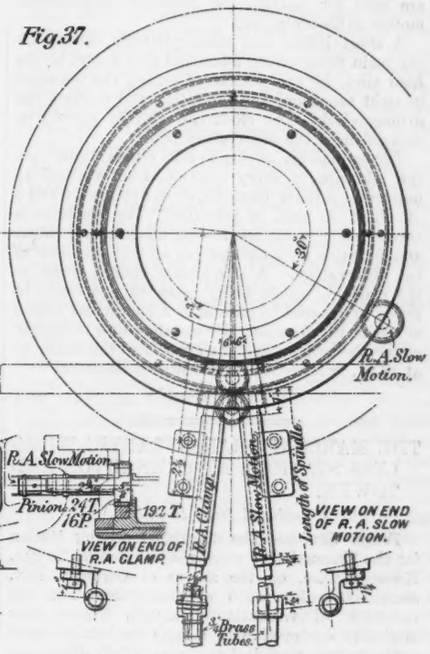
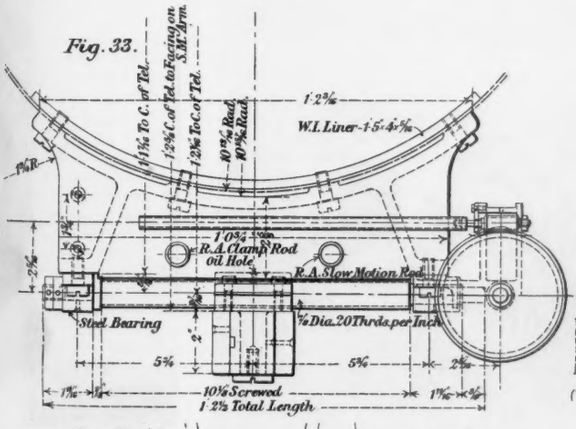
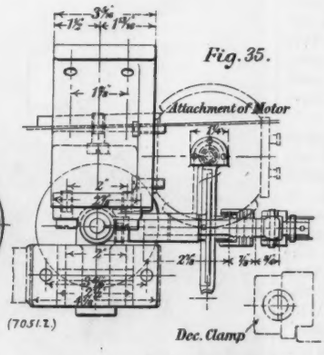


Fig. 36.
6" Dia. Axis
2 10⅝ From Cen. of Dec. Socket.
Pinions: 18 T. 16 P.
160 T. 16 P.
Gears. 216 T. 16 P.
Pinions: 20 T. 16 P.
R.A. Clamp from Hour Circle.
R.A. Slow Motion.
Pinion. 24 T. 16 P.
192 T.
⅝ Whit.







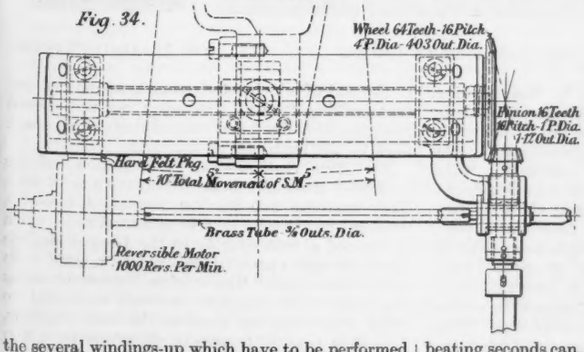


Fig. 34.
Wheel. 64 Teeth. 16 Pitch. 4 P. Dia. 4·03 Out. Dia.
Pinion. 16 Teeth. 16 Pitch. 1 P. Dia. 1·12 Out. Dia.
Hard Felt Pkg.
10" Total Movement of S.M.
Brass Tube ⅜ Outs. Dia.
Reversible Motor 1000 Revs. Per Min.

The driving clock is also fitted with an electric slow-motion by which the mounting speed can be temporarily accelerated or retarded, for fine star setting or guiding, and for circle setting. This slow motion is controllable both from the eye-end of the telescope and the lower end of the polar axis near the hour circle. From both these positions, too, the polar axis can be clamped and unclamped and the telescopes moved by slow-motion hand rods. Electric and hand slow motions and clamp in declination are also made workable from the telescope eye-end. These are shown in Figs. 6 and 7, on Plate XI, *ante*, and in Figs. 31 to 35, annexed. It will thus be seen that complete provision is made for the easy control of the instrument by the astronomer. Certainly the occasional winding up of the driving clock must be done from the observatory floor, but generally this can be left to an attendant, and the observer's hand remain steady for the delicate work of star following and position measuring with the micrometer. Although the instrument is fitted with electric motors and electric illuminations at various points—most of these with their rheostats being controllable from the eye-end of the telescope—the absence of all outside hanging wires, so liable to interfere with the free movement of the telescope, and to get broken in a dark observatory, will be noticed. Electric illuminations are fitted to the verniers of the hour and declination circles, bright and dark fields to the main telescope and its micrometer and to the finder and guider, yet the festoons of electric wires so common on mountings are here avoided by leading the wires up through the centre of the polar axis, inside the declination axis socket and through the telescope tubes. Where rotation takes place, as at the polar and declination axes, insulated brass rings with spring contacts are fitted. These permit of free and complete rotation of both axes, and are shown in Fig. 13, on Plate XII, *ante*, and Figs. 36 and 37 on the present page. In the illustrations just referred to, Figs. 36 and 37 show the electric

contact rings for lamp illumination and slow-motion motors in connection with the declination circle.

Similar but smaller rings are fitted to the polar (see Fig. 13, Plate XII *ante*), and leads from these are taken along the side of the declination axis socket to the narrow points on the telescope which require illuminating, such as the circle verniers, the micrometer telescope field, the cross-webs of the finder and guiding telescope, and the electric switches which hang from the eye-end of the telescopes and are used for starting the reversible slow-motion motors on the mounting.

A short ladder and small platform carried off the main pillar of the mounting give access to the hour circle for the purpose of setting the telescope in right ascension, and for rating and starting the driving clock. The clock can also be started or stopped from the observatory floor.

The astronomer having to take observations with the telescope in every position, from vertical to horizontal, a rising platform, shown in Figs. 4 and 5 on Plate X *ante*, is provided. The platform is carried on a wood framework mounted on rollers and movable on a circular rail around the floor of the observatory. A side ladder affords access to the platform which, being balanced, can easily be raised or lowered by means of a handwheel placed alongside the observer. He can thus alter the height of the platform to suit the eye-end of the telescope at 16 ft., or lower it nearly down to the floor.

(To be continued.)

THE MARCONI TRANSATLANTIC WIRELESS STATIONS AT CARNARVON AND TOWYN.

(*Concluded from Page* 136.)

Towyn Station.—The English receiving station for the Transatlantic service is situated at Towyn, Merionethshire, on the shores of Cardigan Bay, about 60 miles south of Carnarvon. For the reception of transatlantic signals Towyn was originally equipped with a high horizontal aerial supported on steel lattice masts 300 ft. high, and running back from the station building in a line corresponding as nearly as possible to the direction of the American transmitting station. The receiving aerial consisted of two horizontal wires brought down to a suitable anchorage at the station end and from thence into the building itself. The receiver consisted of tuned aerial and intermediate circuits, followed by high frequency amplifications, and finally rectification, after which the signals were passed on to the receivers.

As, in commercial working, it is essential that transmission and reception shall be carried out simultaneously, the station was arranged for duplex working. This was orginally accomplished by erecting a single wire aerial running at right angles to the main receiving aerial and in such a direction as to receive strongly from Carnarvon. The Carnarvon signal received on this aerial was then opposed to the Carnarvon signal in the main receiving aerial by a suitable coupling arrangement. With correct adjustment for phase, &c., a good "balance" could be obtained and simultaneous transmission and reception carried out.

With the improvement of transatlantic receiving apparatus and the corresponding development of high-power transmitters a new and entirely different method of reception has been introduced. The directional properties of frame aerials and combinations of frame aerials have been turned to account, and with the pure and steady emission from a valve transmitter it is now possible to use much simpler arrangements for duplexing and to give more attention to minimising interference due to atmospheric disturbances.

The method now employed for reception at Towyn consists of a combination of the receiving properties of two or more frames. As is well known, two frames erected at right angles to one another and connected to a radiogoniometer or direction finder and other suitable tuning apparatus can be adjusted so as to receive only from one direction, and this direction may be determined by merely rotating the search coil of the direction finder.

Improved Directional Reception.—Considerably improved directional reception is obtained by the system, developed by Mr. Franklin at Towyn, which consists of combining the directional properties of several frames. This directional receiving apparatus is erected about 1 mile from the main station building and consists briefly of a row of four wooden masts 100 ft. high, erected in a line corresponding as nearly as possible to the direction of the American transmitting station. The masts are spaced apart a proportion of the wave-length, and the frames connected by cable to a small central building containing the necessary wireless apparatus.

The general operation is that for a signal arriving in the direction of the line of the aerials there will be a difference of phase of the E.M.F. between the first and second aerials, owing to their spacing. The E.M.F. will be lagging on the second frame by an amount corresponding to the proportion of the wave-length the two aerials are spaced apart. This difference of phase between the two aerials, which varies with the direction the signal is coming from—being zero when broadside on and changing from a lag to a lead when coming from the opposite direction to the transatlantic signals—enables the received energy of two frames to be opposed and a resultant E.M.F. obtained. This resultant can be impressed on suitable amplifying apparatus, whereas undesirable signals such as atmospherics coming from other directions to the signal will produce a resultant which is very small, and will consequently have little or no effect on the signals to be received.

In order to obtain the effect of a large spacing of the aerials, artificial phasing is done in the central building by tuning. This enables the aerials to be placed relatively close together, thus avoiding the use of long connecting cables to the central building. The central building is arranged for the simultaneous reception of two stations on the directive system, using two spaced frame aerials combined for each transmitting station.

The signals from each set of frames on entering the building go direct to direction-finding units, the search coils of which are respectively connected to the field coils of a third direction-finder. In these last-named circuits the necessary phasing of the signals is done. The signals then pass through highly selective intermediate circuits and are amplified by a six-stage high-frequency amplifier, at the end of which interference is introduced and the resulting "beat" frequency rectified, passed through a note filter, and relayed over two telegraph lines to the main station building.

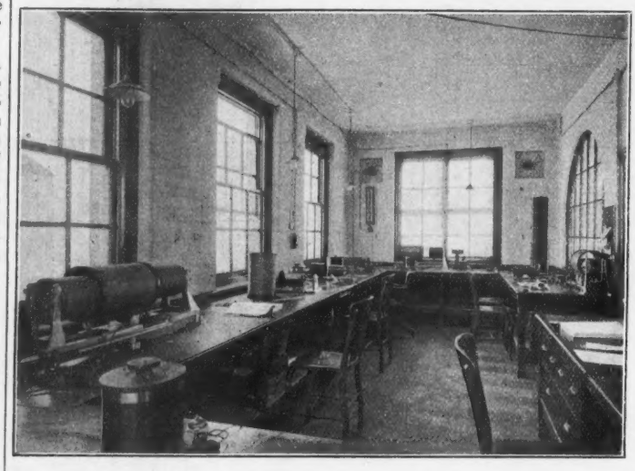


FIG. 9. RECEIVING ROOM AT TOWYN.

FIG. 10. TRANSMITTING ROOM AT TOWYN.

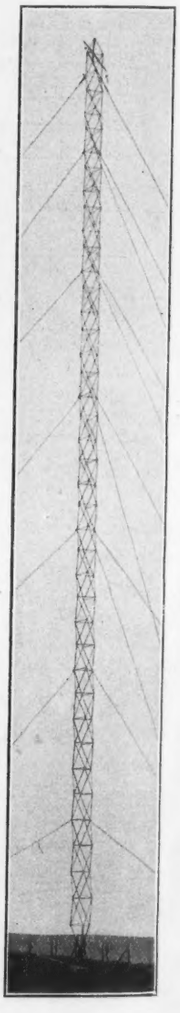


FIG. 11. AERIAL TOWER.

The Main Station.—The main station building is divided into eight rooms, all on the ground floor. They comprise two wireless instrument rooms, a wireless operating room, a large central room which is devoted almost entirely to the London landline apparatus and operating, two offices, a cloak room and a mess room. The wireless instrument rooms are fitted with complete receivers connected to other frames erected close to the main building, thus it is possible to receive altogether from four points simultaneously should occasion demand.

The wireless operating room contains the automatic Wheatstone transmitters which operate the signalling keys at Carnarvon, and two hand keys. The latter are only used for short messages relevant

MARCONI TRANSATLANTIC WIRELESS STATIONS.

Fig. 12. General View of Towyn Station.

to the service to America. The normal method of operation is to transmit everything by the automatic transmitters which are fed directly from keyboard perforators placed alongside. Provision is also made for three wireless receiving operators who, by changing over a switch can, if desired, control the Carnarvon transmitter from a hand key. In the operating room is also placed the high-speed wireless receiving apparatus.

Immediately adjacent to the wireless operating room is the London landline room containing the duplex telegraph apparatus, Wheatstone automatic and high-speed telegraph receiving apparatus, also the keyboard perforators for feeding the landline transmitters with perforated slip from the wireless receivers. Some views of the Towyn Station are given in Figs. 9 to 12 on the opposite and present pages. Figs. 9 and 10 show the receiving and transmitting rooms, while one of the towers is illustrated in Fig. 11. Fig. 12 is a distant view of the station.

Method of Operation.—The general procedure of messages passing to and from America is, broadly, as follows: Messages for America are received at high speed on tape at Towyn from the central London office, and gummed on blank paper. After being checked, they are passed directly to the keyboard perforator operators and run through the Wheatstone transmitter operating the Carnarvon plant. Thus there is the minimum amount of handling of westward-bound traffic and consequently very little delay at Towyn.

Received traffic from America follows practically the same procedure, but, of course, in the reverse direction. Signals from the auxiliary station relayed to the main station are, during high-speed reception, magnified at the main station and adjusted to operate an undulator recorder, thus giving a permanent record at high speed. The received tape is gummed on blank forms, checked and passed to the landline room where the traffic is prepared for transmission to London in the same way as for America. During periods when the transatlantic signals are not good enough for recording at high speed, they are received aurally by one or more operators, depending on the number of circuits in operation at the time.

With the continued steady progress in tape reception methods are being developed whereby all traffic from America is received at Towyn on a tape recorder automatically, thus doing away entirely with aural reception. The station is equipped with its own generating plant to supply the telegraph apparatus and lighting, and also has its own water supply. Residential quarters are provided for the married operators, consisting of detached bungalows erected on the station site.

MULTI-CUTTING TOOL ARRANGEMENTS.

By Joseph Horner.

(*Continued from Page* 98.)

Tool Setting in the Common Lathe, and the Turret Lathe.—The difference between the setting up of tools in these is, that the common lathe is not primarily designed for multi-cutting, the turret lathe is. In this respect the latter has some points in common with the Lo-Swing and Fay lathes, noticed in the preceding article. In the ordinary standard lathe, the setting of several tools may often occupy more time than that of the economies that would result from their employment. Tool-setting in lathes that include no special provisions for that purpose is tedious, and unless it is done to the limits imposed it is useless. Since guess and trial with calipers is necessary, this has to be repeated so often as the tools are re-ground, and re-set. In the special lathes, and in the turret lathes, tools are frequently set with screw adjustments. In the absence of these, setting is done tentatively, and trial made, but the numbers of identical articles produced compensate for the time and trouble incurred. When large numbers of pieces have to be tooled, special provisions can be made in common lathes, as is done in the general shops by the help of the fittings mentioned in the last article, such as the hinder tool post, and the fitting of square, and hexagonal turrets to the carriages of the common lathes.

Tool-holders.—Something may be done with simple tool-holders which in many designs are employed instead of solid shank tools. Thus, Fig. 43, page 164, shows a simple holder fitted with a couple of tools, a round nose roughing, a straight-faced tool, following and finishing. A special holder can be made to carry one tool turning, and another boring the same piece. In each case the relative settings are made in the holder, which can be removed and replaced with its tools without affecting their settings. Facing operations can be combined if a special tool block is made. An example is shown in Fig. 44, where a boss and rim on the same face are being tooled, and a hinder face at the same time with a hook tool. A facing device is shown in Fig. 45. A series of tools in a holder limits the amount of traverse by comparison with that of a single tool. This is suitable for roughing large face-plates. A light finishing cut with a single tool must follow.

Multiple grooving, and cutting off is done with batteries of bladelike tools set up in a special holder held with several clamps, Fig. 46, or with a single clamp plate and screws, Fig. 47. The same method is employed in some built-up tools for forming irregular outlines. The battery consists of two, three, or more single tools each having some portion of the profile, a curve, or a chamfer, or two or more edges set at angles in plan, all clamped side by side, thus saving much time by comparison with that occupied by working with single tools. These lead up to the solid profiled tools used for imparting the outlines to the small cock bodies of the brass finishers.

Turret Work.—In this we meet with numerous aspects of multi-cutting. There is that of several single tools in operation at one time, and that of a rapid succession of tools, the series forming a cycle, during which a single piece is completely tooled, or often, two or more when the pieces are small, and the operations on each few, and simple. The functions of some of the box tools have been greatly extended. These, when massive, are bolted to the turret faces, made flat for their reception. Each box may hold several tools, similar, or diverse in character, and function. Stepped or shouldered pieces can be turned with two, or three cutters in a box, each with its stop, or its steady for setting diameters, while stops and trips determine the length. Tools may rough, those succeeding finish. Centering, drilling, reaming, boring, recessing, screwing, tapping, tapered, formed work, and much else are done.

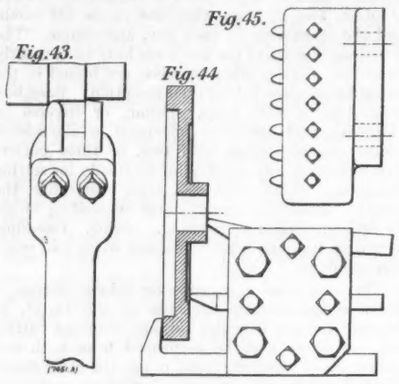
The cross-slide rest may be taking charge of tasks supplementary to those of the turret, as turning, forming irregular outlines, knurling, cutting off, and these may be performed from both tool posts, one of which may also rough, the other finish. There is hardly a limit to the combinations that are possible in a well-designed turret lathe. Its value is therefore largely due to the variety of the operations that can be accomplished in it, more numerous and diverse than those which are possible in any other standard design of machine tool. Each hole in the turret may be the receptacle of a tool, or group of tools different from any others, and the cross-slide with posts at front and back may each carry more than one tool. Screws too long to be dealt with from the turret are chased from a saddle on the bed. No tentative measurements are taken, but dimensions are fixed by the setting up of the tools, and with the stops. There is further the division between work that is centred through the hollow spindle, bar work, and that gripped in chucks, which are now generally relegated to lathes designed for one class of operations, but not for the other. The turret lathe is now often a satellite machine in the present sub-division of operations between machines of different groups. It is employed in the preparation of blanks for gears, spurs, and bevels to be cut elsewhere. The battery of tools enables these to be prepared more economically than is possible in a common lathe. Work may be prepared in the turret lathe to be completed in one of the automatic lathes, and again to be finished in the grinder. Conversely, work may be roughed elsewhere to be finished in the turret lathe, or first and second operations may be divided between separate lathes. There are no set rules, but always the object sought is a subdivision which affords the highest economies.

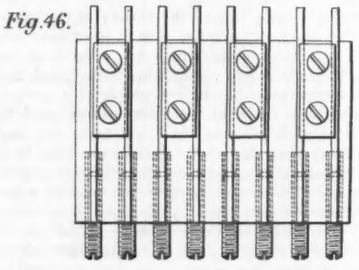
Box Tools.—The earlier box tools were fitted with vee'd steadies set opposite to the tools, both sizing, and steadying the cut. The present tools mostly have roller steadies, with diminution of friction. Three examples will suffice.

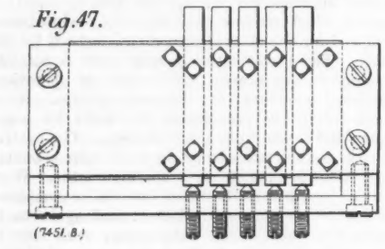
A Brown and Sharpe box tool is shown by Figs. 48 and 49. The rollers fit between slotted slides that are set up with the screws A, and clamped with the screws B. The tool C is set diagonally in the direction of the feed, and can be adjusted on a rocker pad D to bring the edge of the tool into correct position to suit the work. It is clamped with the two screws above. E is a second tool at the rear of the first which is used for taking a second cut if required on shouldered pieces, or for finishing, or ending. It is rocked, and clamped similarly to the other. A vee steady is seen fitted opposite this tool.

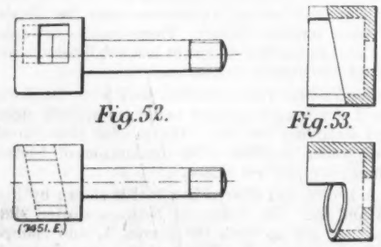
In the steady, Figs. 50 and 51, the rollers A are carried in flat slides, running on pins which are driven tightly into the slides. Adjustments for diameter are made through the screws B, tapped into studs C, the nuts of which clamp the slides

after their adjustments. The screws cannot move endwise because a pin enters a shallow groove turned in the body of the screw. The cutter D is gripped in a slotted bolt E—compare with Fig. 52. A hole is slotted through it at an angle to receive the cutter. A bush F, Fig. 50, has its face cut similarly. When the nut G is tightened on the tail of the bolt, the cutter is secured against the face of the bush F. The lateral position of the edge of the cutter, a little in advance of the roller steady, is set with a bush, having a hexagonal head H, which presses on the back of the bush F, and is then secured with the locknut. The two clamp screws





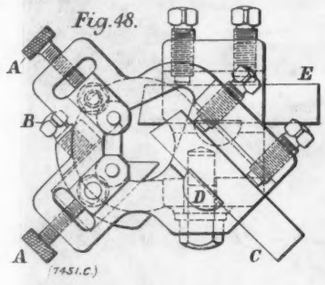


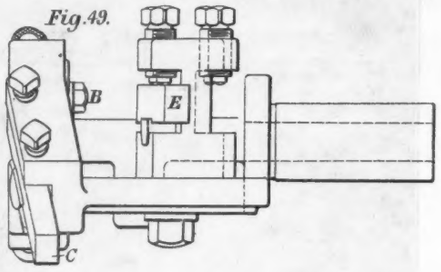


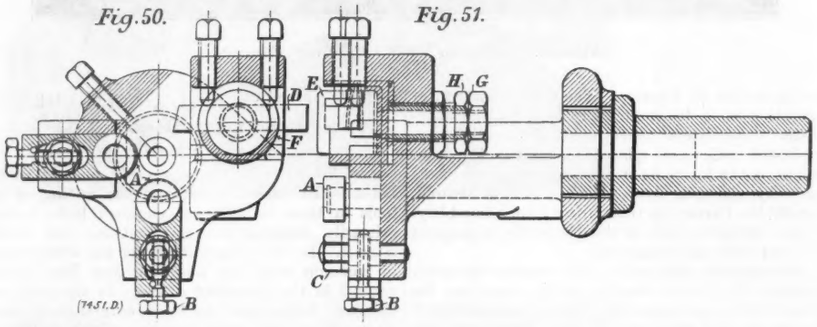
seen above secure the tool. The building-up of the holder is shown. The stem is clamped in one of the holes in the turret.

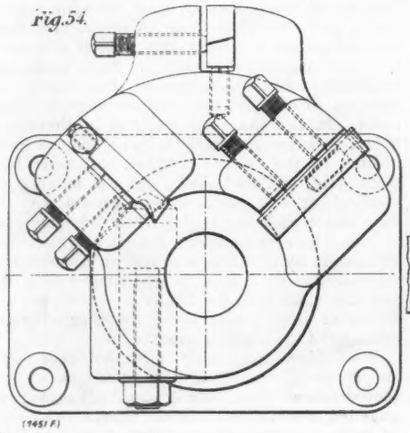
The two views, Figs. 54 and 55, show some of the possibilities of the turret lathe. The example is a massive holder bolted to a turret face with four bolts, through holes seen in the foot, Fig. 54. It carries a boring bar with a pilot end. One cutter is shown, but more are fitted if required for shouldered work, or for roughing and finishing. A reamer can be substituted for the boring bar. The bar is gripped with the locking-pad bolt, seen in Fig. 54, the head of which is hollowed to fit the bar. The holder carries cutters made from steel of rectangular section, with adjustments for radial settings, and set screws. The head carries a boring and a form-facing tool of special outline, and a turning tool. Four tools are therefore shown in this combination, but the number of boring cutters can be multiplied, and tools of varied shapes can be substituted in the head.

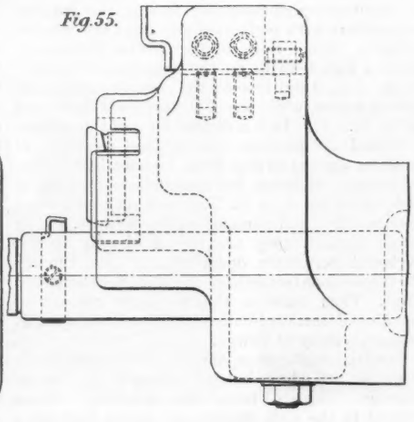
Examples of Work.—Figs. 56 to 59, on page 165, illustrate the complete tooling of a hub for an automobile. It includes rough, and finish-turning and boring, and a re-chucking to deal with the opposite end. Both turret and cross-slide are brought into action. Only three faces of the turret











are occupied with tools, but both tool posts of the cross-slide are.

The casting, chucked as in Fig. 56, is turned with two tools A, on the turret, shown in plan in Fig. 57, the tools facing downwards in the general view. These are held in a bracket bolted to a turret face, which also carries two boring tools, seen in plan in Fig. 57, these being flat cutters, held in a bar that enters a hole in the bracket, and is secured with a set screw. The other end of the bar is a pilot that enters a bush inserted in the chuck, Fig. 56. While the boring cutters rough out three diameters, and counterbore the mouth of the hub, the tools A in the turret, and those B on the hinder post of the cross-slide operate. Those on the turret turn, and chamfer the outside diameter as far as the flange. Those on the cross slide face the flange and the end. The tools are adjusted endwise, each with a set screw, and clamped with a screw and plate. The bore is next finished with the cutters C, similar to those mounted at A, but 1/1,000 in. larger. The tools D in the front tool post of the cross-slide finish the outside simultaneously with the boring by C. A reamer E finishes the bore.

The hub is seen re-chucked in a collet chuck in Fig. 58. A broad tool A on the cross-slide faces the end. A broad tool B in the same clamp faces the flange and forms the radius. Following this, a tool on the turret fitted to a bracket and with a pilot, Fig. 59, carries three turning tools, and a stepped boring tool for roughing, similar to that in Fig. 57, the turning tools being set vertically. A finishing tool follows B, after which a floating reamer completes the bore. At the same time a tool on the cross-slide finishes the diameter of the flange, and chamfers the edge. Finally a die from one of the turret faces finishes the outside of the hub.

The photographic illustrations on pages 165 and 176 show work done on A. Herbert lathes. Fig. 60 shows a piston ring being tooled on a capstan lathe. The bore is being done with a bar held in the turret. Although the ring is eccentric, the turning proceeds simultaneously with the boring. The turning cutter is mounted on a slide arranged to oscillate by means of a cam driven from the rear of the chuck. The rings are cut off with a gang of tools, and this proceeds along with the boring and turning. Fig. 61, page 176, shows the first operation on an aero-valve, one of which at the close of the first operation is seen lying on the turret. The forging is of high tensile steel, and is gripped by the stem, previously rough-turned, while the head is being turned, formed, and cupped out. The cupping tools—flat

MULTI-CUTTING TOOL ARRANGEMENTS.

Fig. 56.

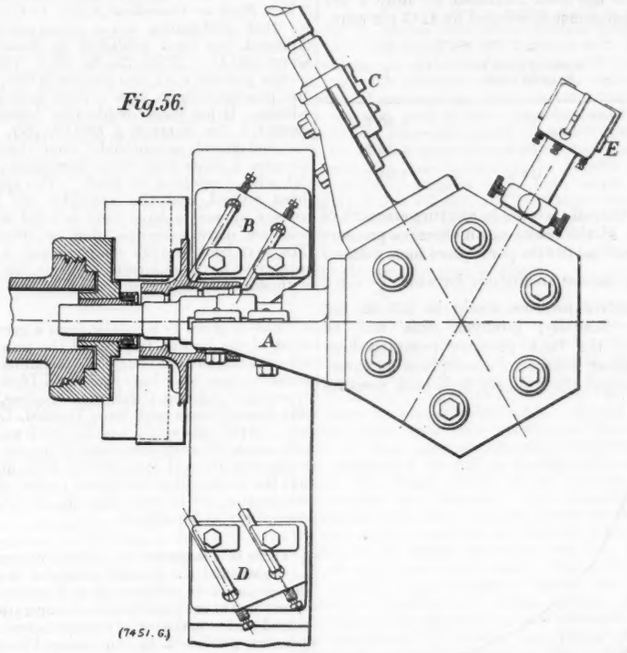


Fig. 57.

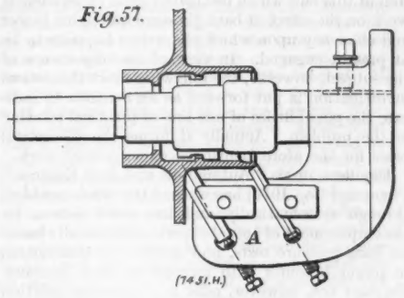


Fig. 58.

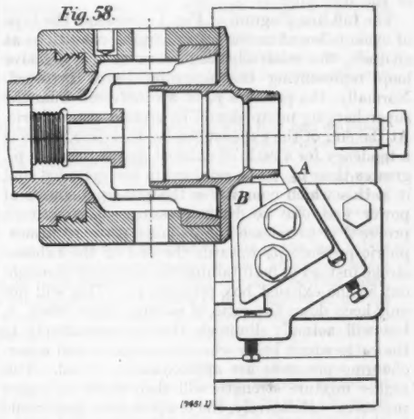
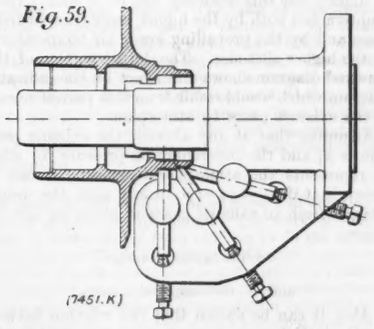


Fig. 59.



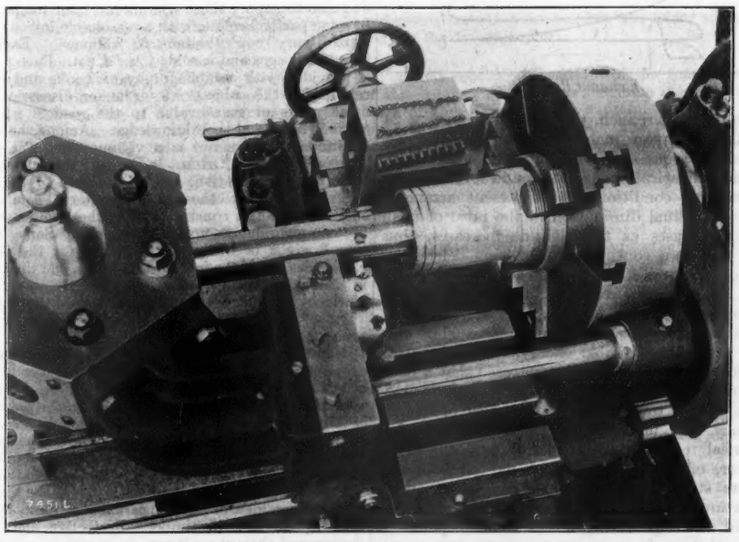


FIG. 60. TURNING PISTON RINGS ON CAPSTAN LATHE.

blades, roughing, and finishing, are seen in the turret, that for roughing being in the axis. The turning of the outside curve is done with a tool in the hinder post of the cross-slide. The reason why the head is tooled in the first operation is, that when re-chucked for the second the stem will run nearly true. Fig. 62 illustrates this. The valve is gripped on the head in soft chuck jaws. The end is centred, and turned a little way from the cross-slide to give a start to the roller steady box tool that then turns it up as far as the head. Finally the stem is drilled—the stage shown—and reamed with the remaining tools on the turret.

The Auto-Lathe.—The A. Herbert automatic lathe has a turret and is cam-operated, similarly to the automatics. All the operations are automatic save the chucking, all proceeding until they are completed, when the machine stops for the removal of the piece and the re-chucking of another. It is built stiffly, and vibration of the turret is prevented by the fitting of a central pillar embraced by an overhanging arm, the foot of which is bolted to the bed. It is a chucking lathe simply, having no loose poppet.

Fig. 63, page 176, illustrates an operation on a motor car hub being done in the automatic lathe. The work is divided between those tools that are fitted both to the turret and the cross-slide for drilling, reaming, facing and turning. The photograph shows two tool-holders on turret faces, and the overhanging arm on the turret. Fig. 64 shows the first operation of the tooling of a gas engine piston. This consists of turning the outside diameters, and forming the grooves. The piston is chucked on an expanding arbor.

(To be continued.)

NEW GERMAN SHIPYARD AND FLOATING DOCK.—With the sanction of the Hamburg Senate a new shipyard is to be erected at Cuxhaven by the Norddeutsche Union Werke, Hamburg. A large floating dock is to be built or purchased and the waterway will be deepened.

AERO ENGINE SUPERCHARGING.

THE problem of maintenance of aero engine power at all altitudes is one which has engaged and is still engaging the attention of engineers in all Air Services, and its importance has been emphasised by the optimistic view taken by Prof. Rateau in his paper entitled "Use of the Turbo-Compressor for attaining the greatest possible speeds in Aviation" which was read before the Institution of Mechanical Engineers at their Paris meeting last summer, and which was discussed at a recent London meeting.* There is no doubt that theoretically it can be shown that power maintenance appears to be possible up to altitudes of 30,000 ft. and beyond, on the assumption of a possible overall turbo-compressor efficiency between 25 per cent. and 30 per cent. This, however, is always based on the assumption of constant mixture strength at all altitudes, and no references, so far as the writer is aware, appear to have been made to draw attention to this important fact. By constant mixture strength is meant not merely air/petrol ratios, means for maintaining the approximate constancy of which are now in general use, but rather the calorific value per cylinder contents of the working fluid at the commencement of compression in the engine cylinder. This is reduced under normal supercharging conditions by the tendency

* We published Prof. Rateau's paper on pages 91 and 123 of our last volume, while a report of the discussion in London appeared in our issue of November 3, page 545.

of the ratio of fresh gases to exhaust gases to diminish as the altitude increases. It was recognition of this fact which instigated some experimental work on the effect of back pressure on engine power and efficiency upon which the writer happens to be at present engaged. In view of the importance of the subject, however, the following short theoretical investigation is put forward as an attempt to indicate the possibilities of one line of practical solution of the problem. Actually it forms the theoretical basis for the afore mentioned experimental work.

Devillers, in his "Automobile and Aero Engines" [Spon and Co., 1919] has worked the whole problem through systematically and has there shown, by the employment of actual experimental results based on back-pressure tests, how serious the diminution in power becomes with increase in back pressure. He does not, however, offer any practical solution of the difficulty.

The full-line diagram of Fig. 1 represents the type of cycle followed under supercharging conditions at altitude, the relatively large area of the negative loop representing the pumping losses involved. Normally, the pressure p_e of air delivered from the supercharging pump should be ground atmospheric. At the end of the exhaust stroke, therefore, there is a tendency for a ratio of exhaust gas at pressure p_1, greater than p_e, to be retained in the cylinder, and it is this which constitutes the principal source of power loss due to back pressure. The writer's proposal is to release the exhaust gases to atmospheric pressure p_a towards the end of the exhaust stroke instead of maintaining the discharge throughout at the exhaust box pressure p_1. This will not only keep down the ratio of exhaust gases retained, but will actually diminish them comparatively to the ratio which holds when the exhaust and supercharging pressures are approximately equal. This higher mixture strength will then result in higher pressures. Relatively, the temperatures also should be higher, but this tendency will be to some extent counteracted both by the higher proportion of fresh gases and by the prevailing lower air temperatures at the higher altitudes. The dotted portion of the annexed diagram shows the effect on the indicator diagram which would result from this partial release of the exhaust gases to atmosphere.

Assuming that at any altitude the exhaust pressure is p_1 and the supercharging pressure p_c, while p_a represents the atmospheric pressure, it can be shown that if $p_a = p_c = p_1$ in any case, the weight ratio of fresh to exhaust gases is given by $a\,r - 1$ where

$$a \text{ is the explosion ratio } \frac{p_3}{p_2}$$

and r is the compression ratio.

Also, it can be shown that the relation between T_c, the initial compression temperature, and T_a, the air temperature, is given by

$$T_c = T_a \frac{a\,r - 1}{a\,(r - 1)}$$

If, however, the more general case is taken when

$$p_1 > p_c > p_a$$

the ratio of fresh to exhaust gases becomes, under the scheme proposed, and following the dotted portion of the annexed diagram,

$$\frac{a\,r - b^{\frac{\gamma^2 - \gamma + 1}{\gamma}}}{\frac{1}{b^\gamma}}$$

where

$$b = \frac{p_a}{p_c}$$

and the temperature at beginning of compression becomes

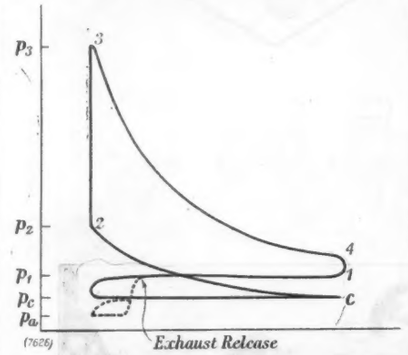
$$T_c = T_a \frac{a\,r - b^{\frac{\gamma^2 - \gamma + 1}{\gamma}}}{a\left(r - b^{\frac{1}{\gamma}}\right)}$$

Taking $a = 5$ and $r = 5$ the values of T_c and the ratio of fresh to exhaust gases are given in the following table for different values of $b = \frac{p_a}{p_c}$.

Obviously, however, the value of a will increase as the ratio of fresh to exhaust gases increases, so that the actual ratio will increase even more rapidly than given in the table. The figures of the table, therefore, represent slightly less favourable conditions than the actual, but nevertheless it can be seen that under such conditions the heat energy of the mixture has been increased by fully 3 per cent. and its temperature reduced by 12·5 per cent.,

$b = \frac{p_a}{p_c}$.	Ratio of Fresh to Exhaust Gases.	T_c.
1·00	25·0	1·20 T_a
0·800	34·8	1·16 T_a
0·200	116·0	1·05 T_a

giving a net overall increase in mixture strength of 16 per cent. If the brake mean effective pressure at ground level is 120 lb. per square inch without supercharging, then at an altitude for which $\frac{p_a}{p_c} = 0.2$ the mean effective pressure would be 139 lb. per square inch. Actually, however, this will be diminished by the back pressure pumping loss. Assuming exhaust release to atmosphere at three-quarter stroke and the unlikely high-back pressure



Exhaust Release

of 24 lb. per square inch, this loss would be $\frac{3}{4} \times 24 = 18$ lb. per square inch, thus resulting in a net mean effective pressure of 121 lb. per square inch, practically identical to that at ground level. Under supercharging conditions as at present arranged, there is an actual diminution in the ratio of fresh to exhaust gases as the altitude increases, thus giving rise to a continually increasing deleterious effect on mixture strength, instead of a beneficial effect, as would be the case under the scheme proposed.

There will be a loss, of course, on the turbine side of 25 per cent. available energy. Even granting this, however, it should be remembered that a back pressure of 24 lb. per square inch is unlikely to arise except with a turbo-compressor system of overall efficiency, say, under 28 per cent. The loss due to partial rejection of exhaust to atmosphere is, however, offset to some extent by the increased mixture strength at altitude. Thus an increase in mixture strength of 16 per cent. will result in an exhaust discharge having a heat value 16 per cent. greater than under normal ground charging conditions, and will, therefore, increase the 75 per cent. discharge which goes to the turbine to 87 per cent. relative to ground level discharge.

The only conclusion possible from this analysis is that, under the most unfavourable conditions involving release of exhaust to atmosphere at three-quarter stroke, the scheme offers a means of constant power development to practically any height with a turbo-compressor overall efficiency of 25 per cent. It is possible, also, that an exhaust discharge to atmosphere at seven-eighths stroke may prove to be sufficient to realise the advantage sought. That, however, must remain at present as a matter for experimental verification.

Bridge Construction, Morocco.—H.M. Consul at Rabat, Morocco, has notified the Department of Overseas Trade that a call for tenders will shortly be made by the Director-General of Public Works, Residency General at Rabat, for the construction of a bridge in reinforced concrete, having three arches of about 44½ m. span and superstructure, to carry the road (No. 8) from Casablanca to Mazagan over the river near Azemmour. The piers, &c., up to the level of the banks (about 5 m.) will not be constructed by the successful tenderer, but by the Government.

NOTES ON NEW BOOKS.

One more edition of the well-known and much-used "*Text Book on Theoretical Naval Architecture*," edited by that well-known naval constructor Mr. E. L. Attwood, has been published by Messrs. Longmans, Green and Co. (Price 12*s.* 6*d.* net.) The first edition of this popular work was printed in the year 1899, and the present volume is a revised version of the 1916 edition. It has been considerably extended in many respects; for instance, a new Chapter, VI, has been devoted entirely to trochoidal wave theory; the new Chapter X deals with screw propulsion; and Chapter XI with propulsion by wind. The appendices have been revised, and the examples by question and answer appear to have been selected with great care and are more numerous than in previous editions. The text book is very complete and is held in high esteem by naval architects, students and all connected with shipbuilding and shipping.

There is given in a concise form a general review of most of the leading features of the principal types of internal-combustion engines, including the petrol, paraffin, gas, and heavy-oil semi-Diesel and Diesel types, in "*Internal Combustion Engines*," by J. Okill (Sir Isaac Pitman and Sons, Limited, London; price 3*s.*). Within the scope of such a small work, comprising only some 122 small pages with 27 figures, it is of course impossible to deal exhaustively with any one phase, but the work will give a broad review of the internal-combustion art to those who do not wish to make a deep study of the subject.

There is a large section of the community who wish to understand the general principles of every modern development in engineering and technology and also something of the construction and operation of the plant introduced to make use of the principles. The technical primers published by Sir Isaac Pitman and Sons, Limited, of London, were designed to meet this demand, and also to supply those who intend later to specialise in some particular line, with a reasonable introduction. This library now numbers 62 volumes. Each has about 120 pages and is sold at 2*s.* 6*d.* net. Each volume is provided with a bibliography of books and papers relating to the subject matter under discussion, and must prove of great value to the readers who are anxious to extend their knowledge. Among the recent additions to the series is a volume on "*The Diesel Engine*," by A. Orton, in which the elementary principles of operation, the relationship of the cycle and performance to those of other internal-combustion engines, and the construction of the components of the complete engine are all dealt with. Some indication is given of the values obtained for the various efficiencies and of the fuel consumptions, and the volume is concluded with a short reference to commercial efficiency, but there is no indication here of the economic value of the engine as compared with that of other prime movers.

With the growth of application of radiographic examination of materials, whether metallic or not, the need for a volume on this subject was felt, and it has been met by the issue of "*The Industrial Applications of X-Rays*," by P. H. S. Kempton. While the author is an enthusiastic believer in the value of the system, yet he is not blinded to the present-day limitations to the use of the method. Some very interesting X-ray photographs are used to illustrate the text and give a clear idea of the appearance of the defects in metal parts and in timber. Protective and safety devices and their necessity are dealt with in an interesting chapter.

Mr. William H. Black has contributed a volume to the series on "*Structural Steelwork*," in which he has treated the basic principles of graphic statics and their application to the design of steel structures. A fully-worked-out example of the design of a steel building, for use as a foundry, provides the necessary information of the use of the general principles in an actual example.

Among the uses of electricity, the application to agriculture is of great importance, for here we must consider all types of electric driving and haulage, pumping, milking, as well as the improvement of yields by electroculture. The effect upon the soil of electrifying actions in rendering the constituents necessary for plant growth more soluble and more easy to assimilate, and the increased flow of sap, formation of starch and sugar, and other actions, are referred to in a volume on "*Electricity in Agriculture*," contributed by Arthur H. Allen, which is a valuable addition to the series.

The relationship of mechanical to metallurgical problems is well seen in the work done in such processes as drop-forging and stamping, and Henry Hayes, in his volume on these processes keeps these matters before his readers' attention throughout the book. After discussing the development of the processes and the equipment necessary for them, the author describes the physical effects on the material, the heat and

hammer treatment of the product, and the dies which are used. Anyone looking for an introductory work on any of these subjects will find the books mentioned not only of interest but also of value.

"*Elementary Internal-Combustion Engines*," by J. W. Kershaw, M.Sc., M.Eng. (published by Longmans Green and Co.; price 5*s*. net), is now issued as a second edition, considerably enlarged in comparison with the first issue. It aims to give a student an elementary conception of the first principles governing the design of internal-combustion engines of all the leading types. The theory of the various processes and systems is more fully developed than the practical side of the question. The work is very fully illustrated, and the illustrations are better chosen than is usually the case in a volume of this scope and price. As is generally the case, when it is attempted to cover such a wide field within the scope of approximately 200 pages, the study of any one aspect is not very deeply carried out, but for those desiring a knowledge of first principles, this book will be found useful.

We have noticed the various reports, which the Department of Explosives Supply of the Ministry of Munitions, and subsequently the Department of Scientific and Industrial Research have been issuing under the title "Technical Records of Explosives Supply, 1915–1918." With No. 9 on "*Heat Transmission*" (H.M. Stationery Office; price 5*s*. 3½*d*., post free) this very useful series of publications has been brought to a conclusion. Mr. W. Macnab, F.I.C., who was responsible for the compilation of these small quarto volumes, acknowledges his particular indebtedness to Professor A. W. Porter, F.R.S., for the theoretical portion of the report. Professor Porter's work, we surmise, is not limited to the theoretical section, the first 16 pages of the volume, of 48 pages—we should mention, that the many full-page plates are not counted in page numbers. These 16 pages comprise the deduction of formulæ for the coefficient of the transmission of heat through pipe walls, new alignment charts for pipes carrying liquids and for pipes carrying gases, and their application to the three main types of heat interchange, the tank interchange (heating or cooling of a fluid in a tank by means of a coil), the counter-current interchange, and the co-current or parallel-current interchange. In the first of these cases, it is shown, the amount of heat transferred is by no means proportional to the length of the pipe; if 20 ft. of a certain piping would cool a liquid from 100 deg. down to 80 deg. C., an additional 20 ft. of the piping would only cool it to 70 deg. (not to 60 deg.), and so on. Further exemplifications of the uses of the formulæ and charts are taken from experiments made at Gretna and at Queen's Ferry, with acid coolers having pipes made of glass, silica, lead or iron and carrying water, acid or gases. These substances were cooled by liquids or gases streaming over the pipes, the cooling being either direct by contact, or indirect by the evaporation of the liquid wetting the pipe. The unexpected observation was made that stirring the liquid in a continuous cooler, consisting of a water coil placed in the liquid within an upright cylinder, actually decreased the efficiency of the cooler by 15 per cent.; this diminished efficiency was ascribed to the faulty design and the insufficient dimensions of the coil. The volume further gives full details of various experiments on the cooling of condenser water by means of Quinan bubbler scrubbers, in which air or gas is forced through a layer of the water supported on a perforated diaphragm, the velocity of the air being sufficiently great to prevent the downward flow of the water through the small perforations, ⅛ in. in diameter. The actual data on volumes, rate of flow, power consumption, &c., make these examples very instructive.

The application of the Diesel oil engine to marine propulsion at the present time, is undoubtedly being retarded by the lack of knowledge amongst certificated sea-going engineers of this prime mover. Shipowners are naturally somewhat diffident on the score of the supply of competent *personnel*, although there is a keen desire amongst the younger members of the marine engineering profession to gain knowledge towards having their Board of Trade certificates endorsed for oil-engine driven vessels. This, of course, is only a passing phase, and the generous response which the author of "*A Manual of Marine Oil Engine Practice*," by J. W. M. Southern (James Munro and Co., Limited, Glasgow; price 25*s*. net) has received from most of the leading manufacturers, shows that the dispelling of any doubts arising from lack of complete knowledge, is realised to be a duty and an immediate necessity. The volume under review fits the present gap between the popular and the purely technical and design aspects of the question of the internal-combustion engine, and being written by one amply qualified to know and to deal with the specific type of reader for whom it is primarily intended, it can be said to be quite the best work of its kind up to the present time. Very comprehensive descriptions, with many arrangement drawings to a good scale, are given of all the leading features of the principal types of Diesel engines. There has not been published a better selection of arrangements of marine internal-combustion prime movers. Of particular merit are the diagrams with descriptions explaining the method of operation, and the principles of the many different types of main engine reversing gears and mechanisms. In preparing students for an examination, part of the curriculum must always be practice in answering questions, and on many aspects of the Diesel engine a large number of questions and answers have been included. In suitable proportion, the auxiliary engines have been dealt with. We commend this volume, and only regret that the high cost of materials and printing makes the price such that its appeal will be more limited than is desirable and would have been the case if it had been possible to produce it at a popular figure.

The study of the processes of engineering drawing is one of the most important of all in the training of young engineers. By the early practice of the art the habits of exactitude and systematic thinking are acquired, for all the parts which go to make up the machine under consideration must be assembled together in proper relationship. Among the many works which have been written on this subject the best of them show step-by-step progression towards the attainment of skill in dealing with complicated work. Mr. Frank Castle, whose book on "*Machine Construction and Drawing*" was originally published seventeen years ago, is among those who have aimed at systematic treatment, and the new edition, recently published by Messrs. Macmillan and Co., Limited, at 7*s*. 6*d*. net, is to be welcomed. The volume contains an unusually large number of figures, showing a great variety of machine and engine details. Short notes accompany the drawings of each example to indicate the purpose of the details. Any young engineer who draws the examples given in this book and works through the exercises will have acquired a valuable experience on which to build in the wider sphere of work in the drawing office.

For that considerable section of the general public of this country which takes a genuine interest in the ships of the British Navy, a useful work has been prepared by Mr. Oscar Parkes. The book is entitled *Ships of the Royal Navy*, and its object is to describe the different types of ships in a semi-technical manner, suitable both for the general reader and for those requiring more detailed information. Battleships are first dealt with, the development of design from the Majestic to the Orion being treated in one section, while separate sections are devoted to the later classes. Representative vessels of each class are illustrated by reproductions from photographs, and, in all cases, particulars of armament, machinery and protection are given, in addition to general information and notes on the appearances of the vessels to assist in identification. Other sections of the book deal in a similar manner with battle-cruisers, cruisers, light cruisers, monitors, aircraft-carriers, destroyers, flotilla-leaders, auxiliary vessels and small craft of all kinds. The aircraft carrier section, we may mention, contains reproductions of two excellent wash drawings by the author, showing the finished appearance of the new vessels Eagle and Hermes. We welcome this new publication, which is to be issued annually in future, since it will tend to foster public interest in the Navy, and in this way to assist the Admiralty in its difficult task of maintaining, under present conditions, a fleet of sufficient strength and efficiency to meet future requirements. It must be remembered that the surrender of the German Fleet at Scapa by no means removed the necessity for the existence of the British Navy. The latter must still be regarded as our first line of defence, although international agreement and the urgent necessity for national economy have led to reductions in its strength which give rise to anxiety in some quarters. An enlightened public opinion, we feel confident, would offer powerful resistance to any attempt to reduce the Navy below the minimum necessary for security, and Mr. Parkes' book appears to supply much of the information necessary to form such an opinion on British naval matters. The price of the book is 6*s*. net, and it is published by Messrs. Sampson Low, Marston and Company, Limited, Overy House, 160, Southwark-street, S.E.1.

In these days propaganda work is employed by people interested in developing the use of any commodity to an extent formerly unknown. An association has been formed of those interested in extending the use of gas to undertake joint advertising and general publicity work for the benefit of all. The campaigns are carried on with great thoroughness but not always with matter that is particularly accurate. A book of notes of lessons for the use of school teachers on the subject of "*Gas, Manufacture, Distribution and Use*," issued by the British Commercial Gas Association is an example of one side of this activity. The work is, of course, of a very elementary and popular character, but accuracy of statement should have been the aim of the authors. As an example of the type of matter that is provided for the guidance of the teachers a statement from Lesson 87, page 95, may be cited. It reads "Six years later" (that is, after the introduction of Lenoir's engine) "Otto and Langen introduced a much more economical engine, using about 44 cub. ft. per hour for each horse-power, worked on what is known as the 'Otto' principle, which is employed in all gas engines to-day." This tit-bit will be appreciated by all who are interested in gas engines; the writer should have avoided mixing up two different inventions in this way. Many of the remarks regarding smoke abatement by the use of "the purified essence of coal" need some slight modification, for there are other factors in the pollution of the atmosphere of large industrial towns than the domestic fire. It is interesting to note that although William Murdock preferred to spell his name as we have printed it, he is referred to here as Murdoch. Educating the public in the ways of progress is commendable, and we think this book may be of service in that endeavour, although it is not free from blemish.

It was, we believe, de Morgan who first laid emphasis on the superior legibility of the old type printed figures having tails extending above or below the general level of the type. In this he has received the support of professional computers as a class. Certain other improvements intended to diminish the risk of extracting the wrong figure through confusion of successive lines have since been introduced, and in the best tables of to-day each successive ten in the argument has a line to itself enclosed between top and bottom bars, the nine intermediate members being spaced in groups of three. It is found that this arrangement much reduces the possibility of a wrong entry. A seven figure logarithm table embodying all these features was published in German in 1869, and has since gone through 13 editions. An English edition, priced at 12*s*. 6*d*. net, is now being issued by Messrs. Chapman and Hall, Ltd., under the title of "*A New Manual of Logarithms*," by Dr. Bruhns. The table of logarithms of numbers constitutes only a portion of the total text, which includes, besides, an extensive table of the logarithms of the trigonometric functions. These are tabulated for angles, varying by single seconds for the regions between 0 deg. and 6 deg. and 84 deg. and 90 deg., whilst for intermediate angles the tabulation extends to every 10 seconds. The first differences are printed against each entry, so that interpolation is easily effected.

The great utility of tables of physical and chemical constants is generally recognised. The work of compilation is, however, far from easy, as to do the work well requires both wide knowledge and sound judgment in order to determine whether or not particular results are worthy of permanent record. This observation applies more particularly to a compilation intended to have a permanent value, and a less meticulous scrutiny suffices when the publication is an annual one. It is, indeed, often useful to an experimentalist to know what has been accomplished by other workers, even if their results are provisional merely. To such the "*Tables Annuelles Internationales de Constants et Données numerique*" are of great utility. The two parts of Vol. IV covering the years 1913 to 1916, have now been issued and are obtainable either from Messrs. Gauthier-Villars et Cie., Paris, the Cambridge University Press, Cambridge, and the University of Chicago Press, Chicago. The text is in French, but the data given are international in character and cover pretty completely the whole field of physics and chemistry, and some attention is also given to the requirements of the engineer. Reference to the original sources are given in each case, so that those who require fuller data or who may be doubtful as to trustworthiness of certain of the figures can easily look up the original paper.

THE ARCA REGULATORS.

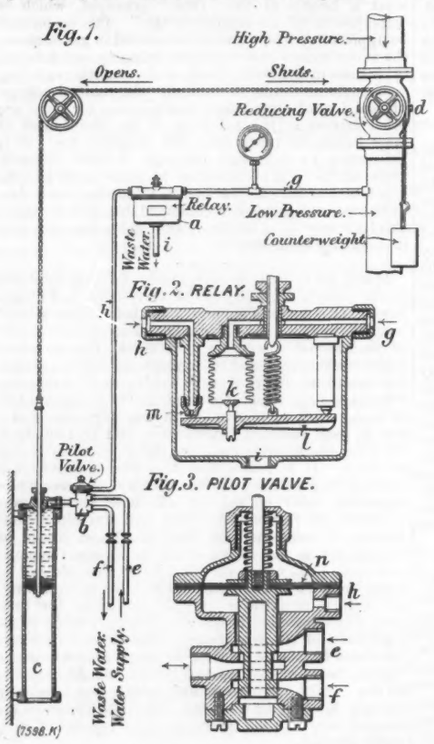
In very many industrial processes it is necessary to regulate some physical property of some material, such as the pressure of steam, the humidity of air, the temperature of a liquid, and so on. The list might be extended to considerable length. Regulations of this kind are frequently carried out by hand, but a closer regulation and one costing less to obtain is usually achieved when a satisfactory automatic regulating apparatus is available. Many such appliances of various kinds are in use in the industries. Some are good and some are indifferent, and no purpose would be served by attempting to describe in a phrase the qualifications of such a miscellaneous collection of

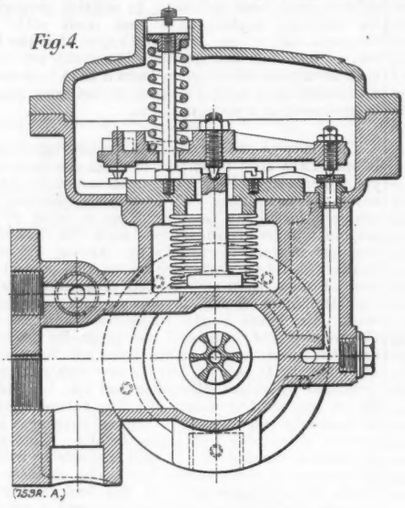
types. It is fair to say, however, that sensitive and accurate regulation is, as a rule, only obtained by sensitive apparatus, which is not difficult to put out of adjustment, and which usually requires fairly skilled attention. This state of affairs lends great interest to the automatic regulator which is described in this article, and which is known as the Arca. This appliance is of quite remarkable sensitiveness and accuracy, and yet contains no delicate parts of any kind nor any mechanism which is likely to get out of order.

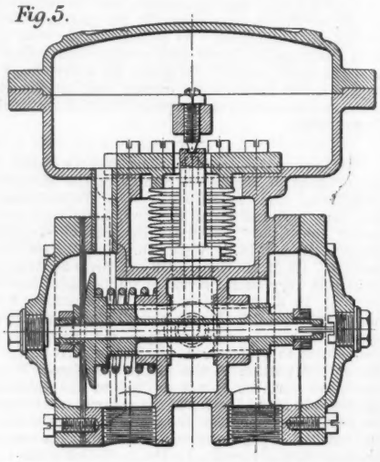
The Arca regulator is a purely mechanical appliance and has none of the electrical features which one is perhaps apt to associate with sensitive regulation. It also has a remarkably wide field of application, and among other uses has been applied for controlling steam, air and water pressures, temperature, humidity, voltage, speed, the density of liquids, the adjustment of the electrodes of electric furnaces and the regulation of the flow of pulp in paper manufacture. It is of interest and importance to note that the same regulator is applied for any of these duties. The variation of whatever physical property is being controlled in all cases is caused to act on a similar element in the regulator. The result of this is that in all its essential parts the regulator is a standard article and can be made in quantity giving all the advantages of large production and convenience in replacements. The Arca regulator is a Swedish invention and has up to the present had its greatest number of applications in Scandinavia. There are, however, a number of installations working in this country. The appliance is the invention of Mr. Ragnar Carlstedt and the patents are the property of the parent company, the Aktiebolaget Arca Regulatorer, of Stockholm. The device is now being manufactured in England by British Arca Regulators, Limited, of Windsor House, Victoria-street, London. It is of interest to note that Messrs. Belliss and Morcom, Limited, are associated in this new company, and that the regulators are to be manufactured at their works.

The operation of the regulator may be described with reference to Figs. 1 to 3 on this page, which show all its essential parts in a somewhat diagrammatic way. Fig. 1 shows the appliance set up for controlling a steam-reducing valve and maintaining constant pressure in the low-pressure main. The relay shown at *a* in Fig. 1 is given in section and to a larger scale in Fig. 2, while similarly the pilot valve *b* is given to a larger scale in Fig. 3. The reducing valve shown at *d* is operated by a chain and counterweight from the cylinder *c*. This cylinder is supplied with pressure water at anything from 10 to 70 lb. a square inch. The actual value of the pressure of supply is of no particular importance and connection to the town mains is usually all that is necessary. The consumption of water is small. As pressure water is supplied to the upper part of cylinder *c* the piston falls, and pulling down the chain increases the opening of the reducing valve *d*. Similarly when the cylinder is put to exhaust the piston rises and the valve closes under the action of the counterweight. Connection to the water supply is made through the pipe *e*, which connects to the pilot valve as shown in Fig. 1. Connection to exhaust is made through the same valve and through pipe *f*.

Before dealing further with the pilot valve and tracing out the water connections we may refer to the relay *a* which contains the regulating feature of the apparatus. As will be seen from Fig. 1, this relay is connected by pipe *g* to the low-pressure main and by pipe *h* to the pilot valve *b*. It also has a waste pipe *i*. From the cross-section given in Fig. 2, it will be seen that the connection *g* from the low-pressure main leads to a corrugated vessel *k*. This vessel is a solid copper spinning and forms a sensitive bellows which increases or decreases in overall length in terms of the pressure inside it, which is that of the low-pressure main. The lengthening or shortening of this bellows causes the fall or rise of the lever *l*, which is supported so that it can swing on the end of the pivot to be seen at its right-hand end. Opposite the other end of this lever there is a nozzle *m*, which is supplied with water through the pipe *h*. This is the same water supply which is used to operate the piston of cylinder *c*. It reaches the nozzle *m* from the supply pipe *e*, *via* the pilot valve *b* and the pipe *h*. The water flowing from this nozzle plays on the end of the lever *l*, which is held up in position by the helical spring which can be seen in Fig. 2.







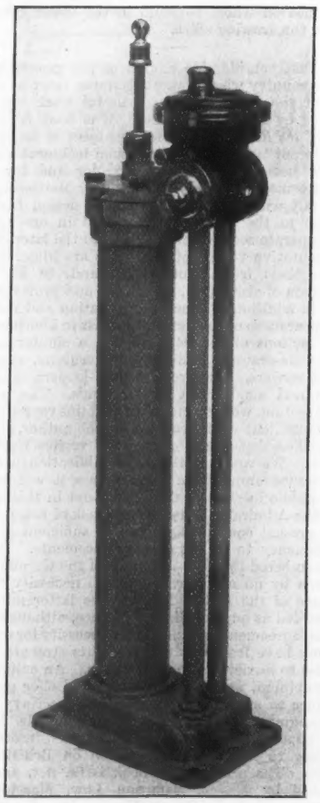
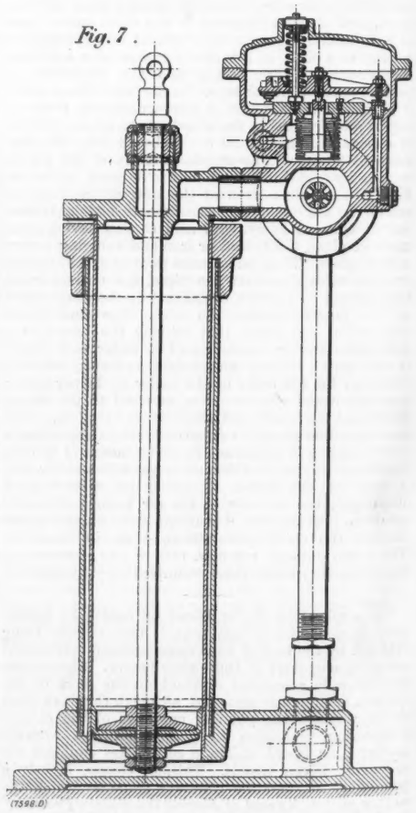


FIG. 6. REGULATOR ATTACHED TO OPERATING CYLINDER.



This spray of water impinging on the end of the lever *l* forms the essential regulating feature of the Arca regulator. If, owing to fall of pressure in the low-pressure steam main the bellows *k* contracts, the end of the lever moves nearer to the nozzle *m*. This restricts the flow of water from the nozzle with the result that there is a rise in pressure in the pipe *h*. This rise of pressure operates the pilot valve *b*, with the result that more water is supplied to the cylinder *c*, so that the reducing valve *d* is opened further. The operation

of the pilot valve will be understood from Fig. 3. As will be seen, the valve casing contains an upper chamber to which the pipe *h* is connected. This chamber has connection with the pipe *e*, so that it is kept full of water. The upper surface of the chamber is formed by a flexible diaphragm *n*, to which the moving part of the piston valve is attached, and as pressure rises in the valve chamber owing to the partial throttling at the nozzle *m* the diaphragm *n* is deflected upwards and carries the valve with it. By means of suitable ports this puts the cylinder *c* into communication with the supply pipe *e*. The action continues until correct pressure has again been reached in the low-pressure steam main, when the lever *l* moves back to its normal position and the piston valve comes to rest. If pressure tends to rise too high in the low-pressure steam main the lever *l* moves further away from the nozzle *m* with the result that the jet flows more freely, pressure falls in the valve chamber and the cylinder *c* is put to exhaust.

As we have already said, the water jet issuing from the nozzle *m* is the essential regulating feature of this appliance. The arrangement is practically frictionless and is quite remarkably sensitive. At the same time the partial choking of this jet in the way described gives ample and instantaneous power for the operation of the pilot valve which can, of course, in turn, be made to control almost any type of apparatus. The water which issues from the jet *m* escapes to waste down the pipe *i*. The jet, however, is quite small, and the water consumption is of little importance. As already explained, and as, indeed, will be obvious Figs. 1 to 3 are somewhat diagrammatic, but an actual arrangement of an Arca regulator of the same type as that shown in these figures is given in Figs. 4 and 5 on page 168. In this case the relay and pilot valve are built as a single unit. The details of the arrangement will be followed from the description already given, and there will be no need to indicate the purpose of the various parts shown in these figures. It should be pointed out, however, that in this case the connection from the steam or air supply which is to be kept at a constant value, is made to the outside of the bellows instead of the inside, as in Fig. 2. This allows of a convenient and compact arrangement for the transmission of the bellows' action to the lever. As will be clear from Fig. 4, this lever is floating on two points, on which it is maintained by the helical spring above it. This makes it very sensitive to alterations in the length of the bellows. As before mentioned, the bellows is a one-piece copper stamping and spinning, and forms a beautiful example of the type of work it represents. Before leaving Figs. 4 and 5, there is a further point to which we would like to direct attention. This has reference to a strainer which is incorporated in connection with the apparatus in order to remove any free impurities which may exist in the water supply, although it may be certainly taken that as a rule clean water will be employed for the regulator, since the quantity used is quite small, and no question of impurities is as a rule likely to arise. The strainer, which is self-cleaning, is incorporated in the design.

The apparatus shown in Figs. 4 and 5 does not, of course, include any power cylinder, such as is indicated at *c* in Fig. 1. By suitable connections the pilot valve may, however, be made to operate such a cylinder or equivalent apparatus. For convenience in erection and in order that the regulator may be supplied as a complete single-piece article, the Arca Company also, however, build the regulator complete with the operating cylinder. Such an arrangement is shown in Figs. 6 and 7. These figures will be understood from what has gone before without further explanation. Another form of the regulator is shown in Fig. 8 on this page. This is a special application for reducing valves. A double-beat valve is employed in order to lessen the work required in operation and the pilot valve is omitted, the variations in pressure induced by the movements of the jet lever being employed directly on a large diameter diaphragm, which operates the valve. The relay chamber is bolted to the valve casing at its back side and consequently cannot be seen in Fig. 8. As will be noted, the reducing valve is in this case mounted with a by-pass.

In all the arrangements of the regulator so far described the movement of the jet lever has been controlled by the copper bellows which are arranged to respond to some type of pressure variation. In other applications in which the relay is installed to act in terms of the variation of some other physical property

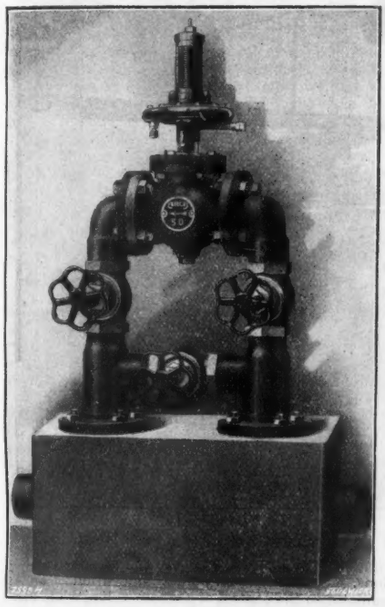
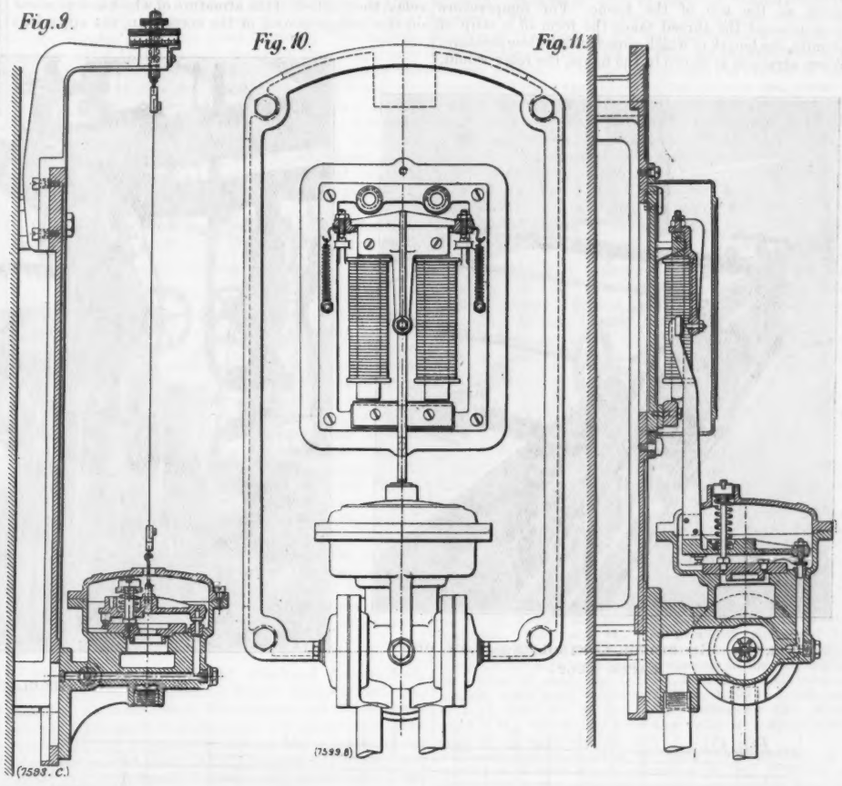


FIG. 8. REGULATOR REDUCING VALVE.



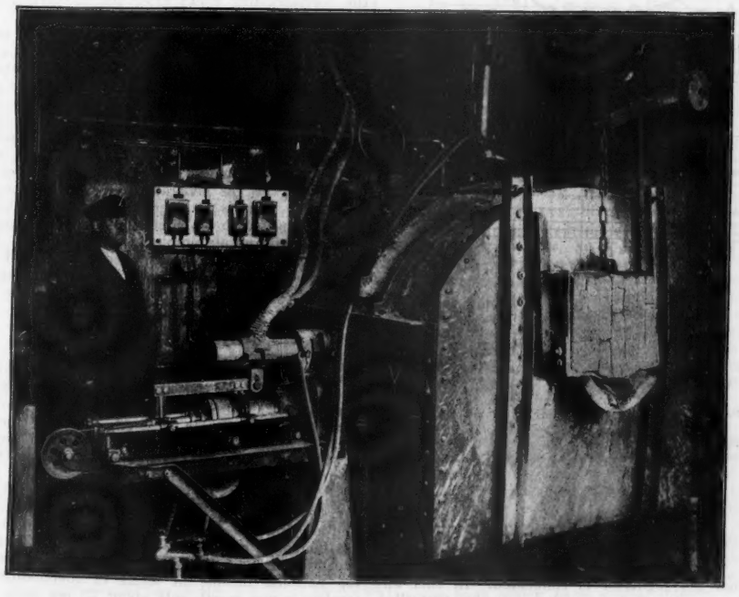


FIG. 12. REGULATOR CONTROLLING FURNACE ELECTRODES.

such as temperature or humidity, the jet lever is controlled in some other way. In every other respect, however, the relay remains as already described. An application suitable for the control of temperature or humidity is illustrated in Fig. 9. As will be seen, the jet lever, instead of being controlled by a bellows, is connected to a thread, or tape of some kind, the tension of which can be regulated by an adjusting screw at the top of the frame. For temperature measurement the thread takes the form of a strip of ebonite, the length of which varies with its temperature. When arranged as shown in the figure, the relay would, of course, be mounted in the chamber, the temperature of which it was desired to regulate. It will be clear that variations in the length of the ebonite strip will result in alterations in the position of the jet lever, so that the resulting alterations in the jet flow may be utilised to operate temperature controlling valves or dampers. The ebonite strip is of large surface and responds very rapidly to alterations in atmospheric temperature. We have had an opportunity of seeing an apparatus of this kind in operation which well illustrated the remarkable sensitiveness of the relay. The mere holding of the hand in the neighbourhood of the strip was sufficient to cause the relay to act and set a valve-operating piston in motion. For humidity control, the ebonite strip is replaced by a series of horsehairs, the length of which is a direct function of the hygrometric condition of the atmosphere in which they are placed.

An arrangement of the regulator for application to electrical work is shown in Figs. 10 and 11. In this case the movement of the jet lever is controlled by a relay, the position of the armature of which is dependent on the voltage across, or the current in, the apparatus to which the regulator is connected. In this way almost any electrical apparatus may be controlled. An application to an electric furnace for controlling the position of the electrodes is shown in Fig. 12, on page 169. As will be seen, the electrodes are moved by hydraulic cylinders which are controlled by the Arca regulator. With an installation of this kind made at the Vaesteras works of the Swedish General Electric Company, the labour of two workmen, who had previously been engaged to regulate the electrodes by hand, was dispensed with, and four heats could be run in a day instead of three. The consumption of electrodes per heat was also reduced. Another application we have mentioned, that of the control of the flow of pulp to a paper-making machine, is illustrated in Fig. 13, on this page. In this case the jet lever is connected to an arm carrying a light roller, which rests on the pulp. If the thickness of pulp varies, the roller rises or falls and so moves the jet lever, which controls the valve in the pulp-supply pipe. The arrangement results in a more even flow with consequent production of paper of a more constant quality. Of our remaining illustrations, Fig. 14 shows an actual application of an Arca regulator to the control of a steam valve, while Fig. 15 gives two curves illustrating pressure variations in an industrial process. The upper curve shows the closest regulation which was obtained by hand, and the lower the corresponding result after the installation of an Arca regulator.

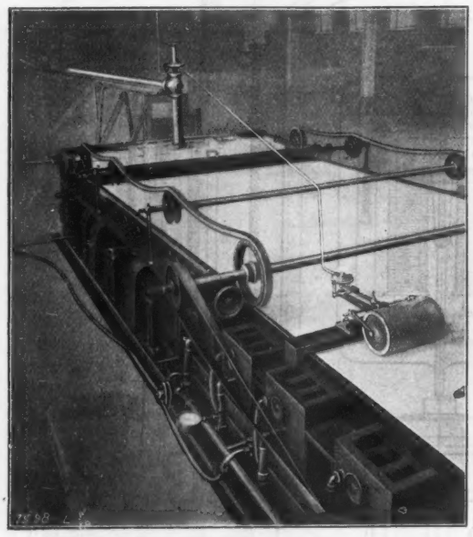


Fig. 13. Regulator Controlling Flow of Paper Pulp.

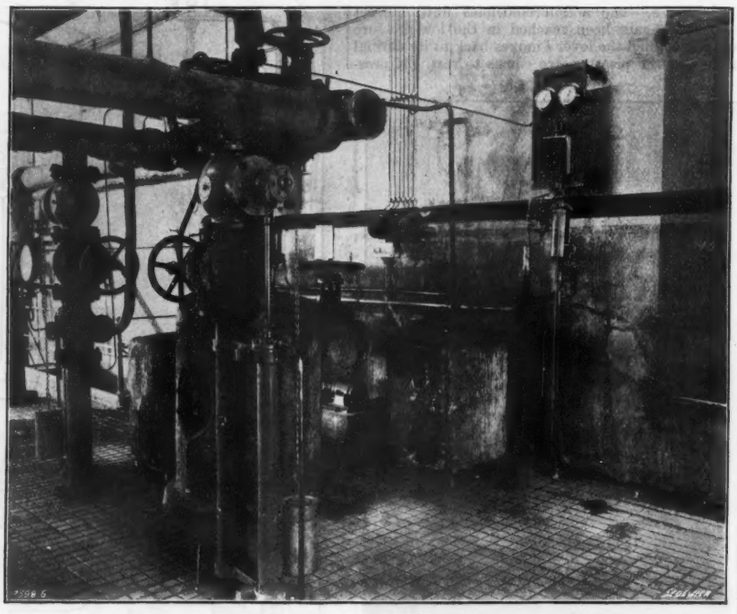
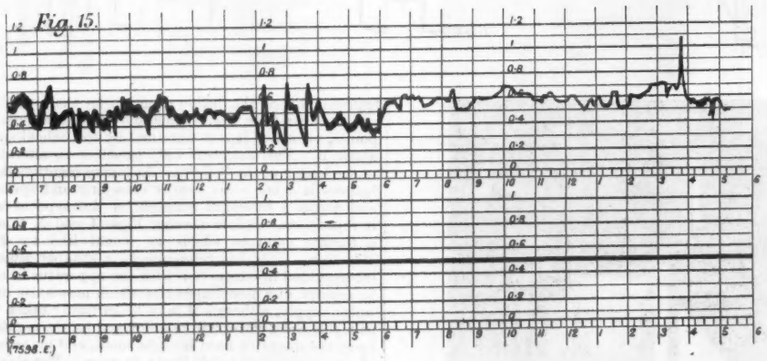
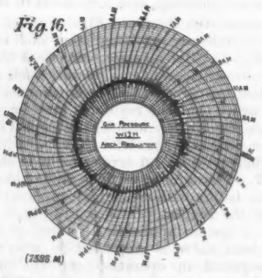
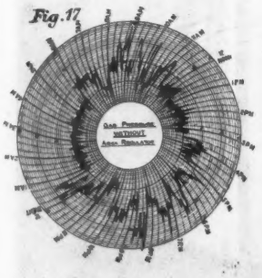


Fig. 14. Regulator Controlling Steam Valve.







The two recorder diagrams given in Figs. 16 and 17 refer to the operation of a gas producer plant in a large Sheffield steel works. Arca regulators are arranged to control the air and steam supplies to the producer and so maintain constant pressure in the gas main. The gas pressures in the main, with and without the regulator in operation, are shown in Figs. 16 and 17. In order to maintain the constancy of pressure which is shown in the former of these two figures it is necessary to control the gas generation in terms of the consumption. This is attained by arranging that regulators connected to the main shall control the pressure of the steam and air supplies to the producer. These regulators are not, of course, required to hold these steam and air pressures constant. They are required to vary them in terms of the demand on the gas main.

INDUSTRIAL NOTES.

The issue, No. 9, vol. iii, of the Bulletin of the British Engineers' Association contains a number of figures of National Exchequer expenditure under the heading of "Civil Services," of which we quote the following for the year 1922–23, those for the year 1913–14 being given in brackets: Old age pensions, 22,619,000*l.* (12,425,821*l.*); public education 55,487,000 (19,169,647*l.*); Ministry of Health and Health Insurance, 13,680,000*l.* (5,341,163*l.*); Ministry of Labour and Unemployment Grants, 22,370,000*l.* (1,161,712*l.*). The table further shows that whilst the national income has increased by only 20·8 per cent., the Exchequer expenditure has increased by 278 per cent.; further, the national income in terms of commodities and services is now worth only about 70 per cent. of its pre-war value.

In another part of the same bulletin a statement is made to the effect that it is only honest and fair to the Government and the people to state quite frankly that there is no possibility whatever of adequate unemployment benefits being provided, under an insurance or any other scheme, unless the annual wealth production of this country be very substantially increased. In order to achieve this, the selling prices of our goods must be brought within the purchasing

power of the markets of the world. Our only real chance of accomplishing this lies in the release of our large untapped reserve of productive power, by the removal of restrictions on output which are now making it impossible to add to the wealth and comfort of the whole nation.

A meeting took place in London at the end of last week between committees of the Shipbuilding Employers' Federation and the Federation of Engineering and Shipbuilding Unions, on the question of overtime on exceptional and urgent work, and on night shifts. At the close of the meeting, Mr. Frank Smith, secretary of the latter body, stated that "some progress had been made, but no definite conclusions had been arrived at, and the meeting had been adjourned until Thursday (yesterday, the 8th inst.); he added that some very complicated questions as to rates, &c., were involved, and it was not an easy matter to reach an agreement on a broad national basis."

In the meantime work is going to Continental yards. Thus a ship now lying at Hull is to be repaired at Rotterdam at a lower cost and more quickly than would obtain in a British yard; another, a large Glasgow steamer, is already in Rotterdam for extensive repairs, in regard to which British yards decided not to quote owing to the very limited chance they had of receiving the order; a third vessel, a Greek steamer is to be repaired at Antwerp, the continental firm having quoted a lower price and shorter time for the work. There is urgent need for "the removal of restrictions on output," to quote the bulletin above referred to.

According to the Glasgow correspondent of the *Manchester Guardian*, some alarm has been expressed on the Clyde at the volume which the emigration from the area of skilled workers to America and other countries has gradually assumed, as the result of prolonged unemployment and distress. Officials of the United Patternmakers' Society state that in recent weeks an abnormal number of their members have been leaving for the United States. Many of the emigrants, it is stated, are among the best craftsmen, and when better trade conditions return it may be found that in some trades there is a shortage of skilled workers. The men who have left the Clyde have in the majority of cases gone to certain employment at, it is stated, wages about double the amount which they can earn in this country.

This is rather too bare a statement, since it omits all reference to the fact that the United States' works and yards are not run for the sole welfare of their employees, but demand an output corresponding to the pay given, as these Clyde men may soon discover. It omits also all reference to rent and other costs of living which come on the debit side of the men's budget.

The length to which men who are in receipt of the dole are prepared to go in declining work is illustrated by a recent case. Work was offered in the Belfast yard of Messrs. Harland and Wolff to 120 Govan ship joiners, to complete the work on a large Dutch liner, the firm desiring to give Govan men the first chance of the employment. The wage offered was 3*l.* per week, the standard rate for Belfast, and 8*s.* 6*d.* per week above the rate for ship joiners on the Clyde. The work was to take about two months. A few men accepted the offer; the large majority, however, declined, and these have had their unemployment benefit suspended. They argue that this has been wrongfully suspended, contending that Ulster is a foreign country in the same sense as other overseas parts of the Empire. The matter has been referred to the Chief Insurance Officer for consideration.

An example of the over-bearing attitude of unions in this so-called free country is afforded by the report which reaches us of a meeting which was held in Newcastle, last Saturday, to consider "the best methods" to be adopted to eliminate the non-unionists from the ranks of the railway men in the North Eastern area of the London and North Eastern group. The matter was discussed for one hour, and the best method arrived at is framed in the following resolution, which was carried:—"That this conference urge the Executive Committee of the National Union of Railwaymen to sanction the men ceasing work one day per week until all workers on the North Eastern area join the National Union of Railwaymen." From this it will be seen that the Executive Committee of the N.U.R. is to decide the point finally.

In a report upon bulletin No. 27, issued by the Women's Bureau, Department of Labour, *The Iron Age*, New York, states that the iron and steel industries of the United States employed 70,410 women in 1920, as compared with 29,697 in 1910. This included a wide variety of industries covering plants using iron and steel as the principal articles of manufacture. The automobile factories accounted for 12,788 women as semi-skilled operatives in 1920, only 848 being similarly employed in 1910. In blast furnaces and steel rolling mills women operatives numbered 4,101 in 1920, or nearly twice as many as in 1910. These women were not employed in actual operation of either the furnaces or the mills, but in certain departments attached to such plants. The number employed in iron and steel factories and foundries manufacturing machinery and other iron and steel products was 36,338 as against 16,043 in 1910. Figures given for other mechanical industries also point to a great increase. The bulletin further states that although the census was taken only fourteen months after the close of the war, and the industrial prosperity due to the war still existed, the fact must not be overlooked that there was a greater increase from 1900 to 1910 in the number of women employed in the iron and steel industries, indicating that women were already firmly established there even before the war, and that the industrial upheaval due to the war served only to accelerate a movement already well under way.

Had it been possible to add the total figures for 1922, the information would have greatly gained in interest.

YEAR-BOOKS AND ANNUALS.

The Association of British Chemical Manufacturers, Incorporated.—A very useful official directory has been issued by this association, giving the names and addresses of its members and a classified list of their manufactures. This latter list includes the names of all the products manufactured, pharmaceutical chemicals, dyes, extracts, products used in various industries, and under each the names of the British makers are printed. The full address of the makers is obtained from the list of members which opens the book. The names of the products are given in English, French, Spanish, Italian, Portuguese and German, and there are indexes to the products in all these languages. A special chapter deals with products under their proprietary and trade names and gives their chemical description in the different languages. The book is very neatly printed and will form a useful guide to many trades and to a large number of commercial firms all over the world. It can be obtained at the price of 10*s.* 6*d.* from the offices of the Association, 166, Piccadilly, W. 1.

The "Mechanical World" Electrical Pocket Book, 1923.—This is published by Messrs. Emmott and Co., Limited, 65, King-street, Manchester, and 20, Bedford-street, London, W.C. 2 (price 1*s.* 6*d.* net). It is well-known among engineers generally, and is made up for the most part of short descriptive articles bearing such titles as "Rectifiers," "Notes on Electric Lifts," &c. The amount of tabular matter, which forms the main feature of some engineering pocket books, is comparatively small. These short articles giving the outlines, and setting out the main features, of the various sub-branches of electrical engineering are frequently of much value particularly to junior members of the profession, but we think the useful scope of the book could be considerably widened if the source of the information given was indicated and if there was less apparent reluctance to mention the names of firms or individuals responsible for any particular development. There is, for instance, a short article on "The Transverter," but no indication is given of where the information has been obtained, who the apparatus is due to, or what firm, if any, is building it on a commercial scale. As another example, an "arc-incandescent" lamp is described in which a small arc is maintained between a tungsten ball and a tungsten filament in an atmosphere of nitrogen, but as far as we can find, the name "Pointolite" does not appear in the book, and no indication is given of where such an "arc-incandescent" lamp can be obtained. We cannot think that this omission of the connecting links between technical descriptions and applications to practice adds to the value of the book.

The Swedish Year-Book, 1922.—This year-book in the English language forms, in a small compass, a very complete encyclopedia on Sweden, in that it deals with the history, the Government, finances, law, social life, commerce and industry of the country. To business men it will prove of special value by reason of the information it contains in the matter of trade and trading conditions, natural resources (mining and others) of Sweden. There are many other chapters in the book which have special interest for a wide circle of readers. The exhibition which it is proposed to hold in Gothenburg from May to September next, to celebrate the 300th anniversary of the foundation of the town, will most probably attract a large number of visitors from this side, both business men and tourists, and to these the book will prove a most useful guide. It is edited and published in Stockholm, and is issued by the Swedish Consulate in London, 329, High Holborn, W.C.1.

Taschenbuch der Kriegsflotten.—By Captain B. Weyer; published by J. F. Lehmanns Verlag, Munich. (Price 8*s.* 6*d.*) This German year-book for the current year opens with tables of the units forming the German and other navies, including the Russian Navy, giving the names of the ships, their tonnage, speed, armament, armour, radius of action, fuel capacity, dimensions, builders, &c. Then follow views, side elevation and plan of typical ships, and tables comparing together selected battleships and cruisers of various naval powers. The long chapters on the alleged causes of the Great War and on the war itself, which formed a special feature of the book for 1922, are omitted from the present edition. This latter contains the clauses of the Versailles Treaty that apply to the German sea power; data on the Washington Conference and a review of the various navies in connection with the clauses elaborated at the said conference. The book will prove interesting for reference purposes. On page 259, where there is a table giving the corresponding rank of naval officers, it would seem to us that under Italy "Ufficiali Macchinisti" are intended and not the officers of the "Genio Navale."

Almanacks and Calendars.—We have received a monthly tear-off calendar from Messrs. August's Muffle Furnaces, Limited, Halifax; also a wall calendar depicting the New County Hall, London, from Messrs. Joseph Westwood and Co., Limited, bridge builders and constructional engineers, Napier Yard, Millwall, London, E.

SPECIFICATION FOR PERMANENT MAGNET STEELS.

TO THE EDITOR OF ENGINEERING.

SIR,—An alternative point of view to that of Mr Ellis H. Crapper, as given in ENGINEERING, of February 2, page 129, may be of value.

Ideal soft iron has a saturation intensity of magnetisation (I_s), its saturation residual magnetism (I_{rs}) is equal to I_s, so that I_{rs}/I_s is unity, and its saturation coercive force (H_{cs}) is zero. As hysteresis is developed by hardening, I_s remains unchanged, I_{rs}/I_s decreases from unity, and H_{cs} increases from zero. The minimum value to which I_{rs}/I_s tends, and the maximum value to which H_{cs} tends, as hysteresis increases, depend, like I_s, on the material. I_{rs}/I_s and H_{cs} are probably connected by some simple law, but at present we must consider that there are three independent parameters in the magnetism of a piece of steel, viz, I_s, I_{rs}/I_s and H_{cs}. All modern magnet steels have values of I_s from 1,200 to 1,400, and of I_{rs}/I_s from 0·7 to 0·5. The parameter that alters most is H_{cs}, which may have any value in magnet steels from 60 up to, or beyond, 250.

The energy involved in reversing the magnetism of a specimen of steel from saturation in one direction to saturation in the other direction, is expressed by $2H_{cs}\ I_s$; and thus I_s is almost of more importance than the residual magnetism I_{rs}, in that the material must be given a value of I_s in the process of reaching I_{rs}, and the energy expended in this process (and therefore the energy required to remove I_{rs}), is measured, not by I_{rs}, but by I_s, along with H_{cs}.

The quality of steel for permanent magnets may thus be fully represented by the three quantities:—

Saturation coercive force, H_{cs};
Coefficient of retentivity, I_{rs}/I_s;
Saturation intensity of magnetisation, I_s.

Mr. Crapper gives minimum values of 58, 65, 200 for H_{cs}, of 0·65, 0·7, 0·625 for I_{rs}/I_s, in his three types of materials; and a minimum value of 1,200 for I_s in each type would complete the specifications. If the values of the three quantities referred to are found satisfactory, the values of the other quantities given in Mr. Crapper's suggested specification will also be found suitable.

I am, yours truly,
ROBERT COCHRAN GRAY.
Natural Philosophy Institute, The University, Glasgow.

PUBLIC LIBRARIES AND ENGINEERING TRADE CATALOGUES.

TO THE EDITOR OF ENGINEERING.

SIR,—For some time past I have been endeavouring to bring together a representative collection of trade catalogues in the engineering industry, for the use of students in this city. Most of your advertisers and subscribers will doubtless have received my printed application during the past six months; but I hope that you will grant me space in your columns to ask for the co-operation of your readers in this work, in order that the collection may be made as representative as possible of the engineering industry in England. These catalogues are arranged in strictly classified order in our commercial and technical library, and form a very useful adjunct to the books and periodicals which are filed in that library; and I hope that all representatives of firms that see this letter will favour me by sending a complete catalogue of their productions for filing in this collection. I may add that the collection, which is not wholly confined to the engineering industry, already contains some thousands of catalogues of very recent date.

Yours faithfully,
CHARLES NOWELL,
City Librarian.
Central Library, Coventry, February 3, 1923.

TRIAL ROLLING-STOCK FOR THE LONDON TUBE RAILWAYS.

An inspection was arranged on Saturday by the London Underground railway authorities, of some trial stock which has been built recently by various firms. This rolling-stock is for tube operation, and the visitors on Saturday, after assembling at Piccadilly were taken in one train to Finsbury Park, and thence in a second train to Barons Court. On each train there were three new cars of varying design.

These cars are the outcome of an uncommon experiment by the Tube Railways. They have been built by five different makers who were left as free a hand as possible by the railways in the matter of design and finish. The purchasing company insisted upon adherence to certain features such as cross-section, area and position of doorways, air-operation of doors, and so on. The firms with whom the orders were placed were Messrs. Cammell Laird and Co., Limited, Nottingham, The Birmingham Railway Carriage and Wagon Company, Limited, Smethwick, The Gloucester Railway Carriage and Wagon Company, Limited, Gloucester, The Leeds Forge Company, Limited, and the Metropolitan Carriage, Wagon and Finance Company, Limited, Birmingham. Needless to say the result has been very interesting, though we may say at once that although several of the cars are very pleasing in effect as regards interior decoration, lighting, &c., they do not by any means all strike one as suitable for tube railway service. An order for a sixth car was placed with the Gloucester Railway Carriage and Wagon Company, Limited, to the designs of the Underground Company itself, worked out we understand at Ealing under the superintendence of Mr. W. Agnew, the company's chief mechanical engineer.

We do not propose to deal in detail with these experimental coaches. In certain respects we think it evident that the question of expense must rule out some of the features they embody. On the other hand there are many points in them which will be appreciated by the public and will probably find embodiment in the standard design of coach ultimately adopted. The new trains when ordered and built will be put in service upon the Hampstead and City and South London Railways, between Hendon (Central) and Highgate and Moorgate. The trains will therefore run above ground over part of their route.

In the new coaches there are no end platforms and doors, but two wide double doors are provided in each side, sufficiently far from the ends to divide the interior up into spaces which can be expeditiously filled and emptied. Provision for this formed a feature of the stock for the District Railway which we illustrated some while ago*, and has since been found a great improvement on the old system of end and central doors. Among the many features in the sample coaches the provision of frameless plate glass windows was noticeable. This excellent type of window was introduced many years ago on the Continent, first, we believe, in Switzerland. It is being slowly adopted here, but its neatness and simplicity seems hardly yet to be appreciated. Another feature is the improvement in the straps to which unfortunate passengers have to attach themselves. Strap-hanging is an uncomfortable business for anyone, and particularly so for any person otherwise than tall, but there is no reason why it should be made unnecessarily painful by the strap being contrived in such a manner that the fingers are squeezed in the effort to maintain an upright attitude. Some of the new forms of straps are more in the shape of rings, in some instances wooden-lined, and these enable a comfortable grip to be maintained with the ring well in the palm of the hand. These rings are attached to straps, or to shanks on swivelling brackets, but are fixed along the length of the car.

In the matter of small fittings the same cars are well finished, though there was in some instances a tendency to depart from the simplicity which we consider a good point in recent coach design. The effect in some of the coaches of the oxidised silver fittings was very pleasing, but on the whole it is probable that in the London atmosphere bronzing would be a better form of treatment. The interior arrangements show small differences in the disposition of the seats and a considerable variety in the ideas as to what constitutes suitable upholstery. Some of the latter can hardly be said to be tasteful, while the most tasteful is probably too delicate to be serviceable in London. Two cars gave a particularly pleasing effect as regards the general appearance of the interior, namely, that by the Birmingham Carriage and Wagon Company and the one by the Gloucester Railway Carriage and Wagon Company, Limited.

The car by the Gloucester Railway Carriage and Wagon Company, built to their own design, is illustrated in Figs. 1 and 2, on this page. It is mounted on two bogies of Gibbins' spring-frame type, an illustration of one being given in Fig. 2. In this bogie the load is taken direct on roller side bearings and not on the centre pivot, eliminating side rolling, which has been unpleasantly in evidence on some of the tube railway stock. The body of this car is insulated with "wadnit" rammed between the inner and outer sheathing. Windows are frameless and drop 6 in.; provision is also made for blinds. The doors are sheathed with aluminium and are fitted with flexible rubber edges. Wood-lined ring straps, such as we have referred to above, are fitted to this car as shown in Fig. 1.

On the whole we feel bound to state that as a practical proposition for London single-class service the car which appeared to us to be the most suitable was that designed by the Underground Railway's Mechanical Engineer's Department, and built by the Gloucester Company. Though not the equal of some of the others in artistic pretensions this car was fitted and upholstered in a very serviceable manner, and would, we believe, give a very good account of itself in traffic. This could not be said with equal certainty of all, while as regards cost the railway-designed car would undoubtedly have the advantage over some of the others. We should not be surprised to find, when the standard car design appears, that it embodies a good many features of this car, possibly combined with points which have been brought out in the others.

* See Engineering, vol. cxi, pages 12, 37 and 102.

TRIAL ROLLING-STOCK FOR LONDON TUBE RAILWAYS.

CONSTRUCTED BY THE GLOUCESTER RAILWAY CARRIAGE AND WAGON CO., LTD.

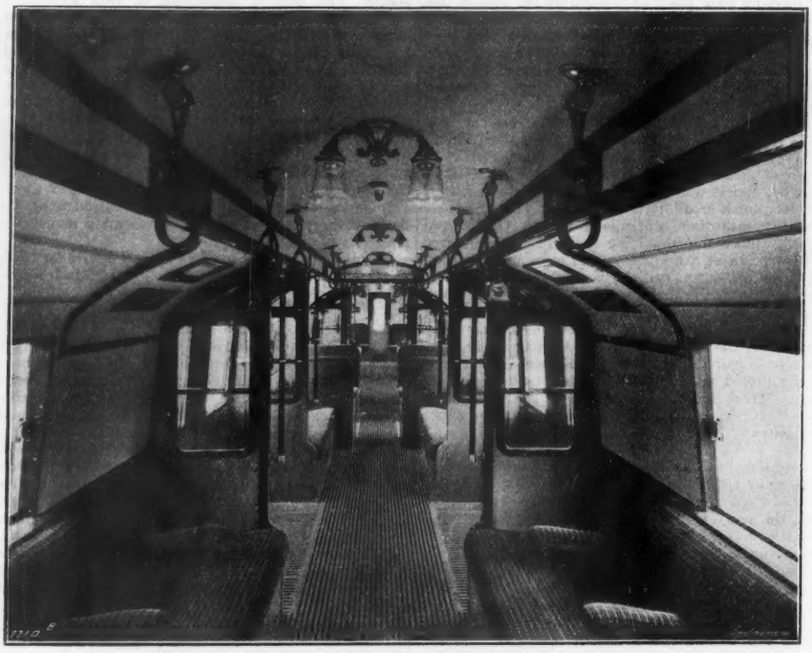


Fig. 1. Interior View.

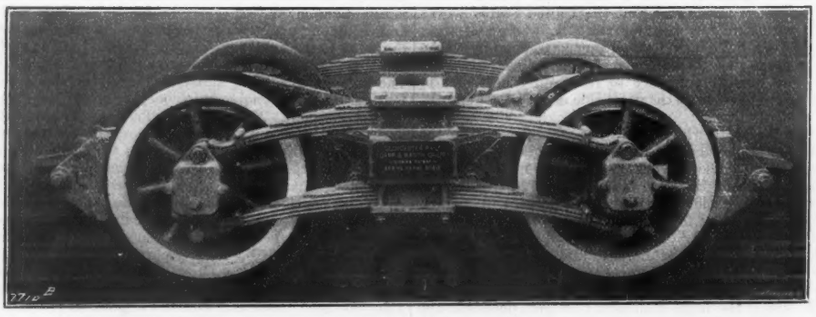


Fig. 2. One of the Bogies.

Motor Taxation Inquiry.—The fight of motor users against the present system of motor vehicle taxation opened at Westminster on January 26, when Sir Arthur Stanley, chairman of the Royal Automobile Club, gave evidence before the Departmental Committee on the Taxation and Regulation of Road Vehicles (Ministry of Transport). A proposed new system of motor taxation by a flat rate duty on motor spirit has been laid before the Departmental Committee by the principal motor organisations, representing all classes of motor vehicle owners and every branch of the motor industry. Subsequent sittings were held and the inquiry is proceeding.

The Institution of Aeronautical Engineers.—On Friday last, the 26th ultimo, a lecture entitled "Wind Tunnel Work at the National Physical Laboratory," was delivered by Mr. W. L. Cowley, A.R.C.S., of the laboratory staff. Actually the lecturer dealt with the plant and apparatus at the Laboratory more than with the work carried out, giving particulars of the various wind tunnels, including the new 14-ft. by 7-ft. duplex tunnel and illustrating them by means of numerous lantern slides. The accessory apparatus and methods of testing employed were also illustrated and explained in considerable detail, and reference was also made to the question of scale effect. The subject of model testing is one of considerable importance in connection with the development of aeronautics, and the lecturer, from his theoretical knowledge and practical experience of this class of work was able to make his lecture both interesting and useful to an attentive audience.

THE MACKELSON AUTOMATIC COUPLER.

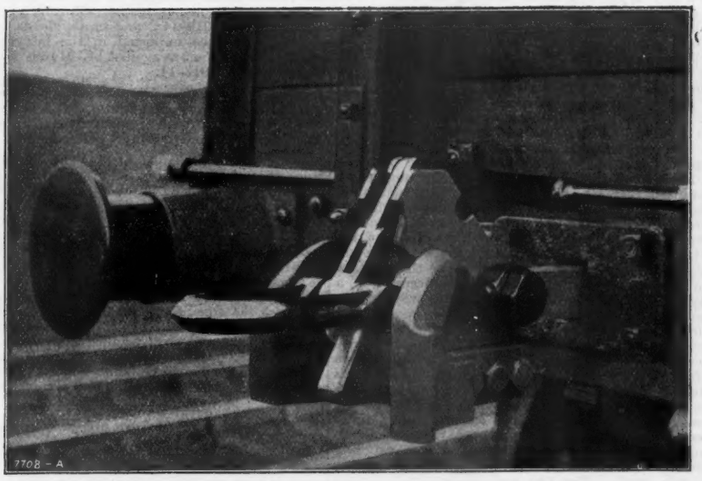


FIG. 1.

Fig. 2.

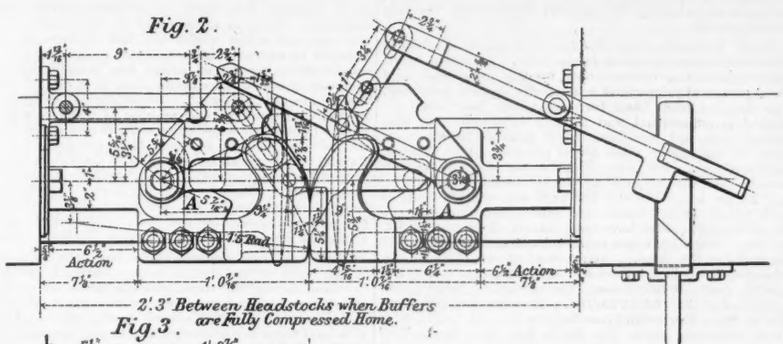


Fig. 3.

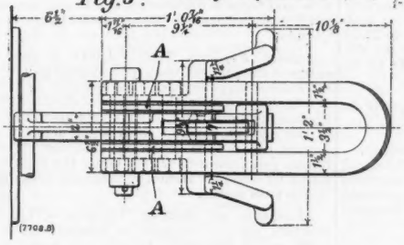
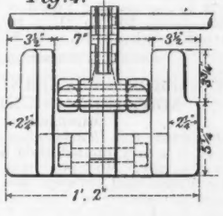


Fig. 4.



THE Mackelson automatic coupler which we illustrate in Figs. 1 to 4 annexed, is designed primarily in the pattern we show, as a transition coupler to bridge the period of changing from the loose link coupler and side buffers to full automatic action and central buffing. Like the A.B.C. coupler, which has been successfully used for many years, the Mackelson coupler employs a single link or shackle, but the latter has a hook solid with the draw bar shank. The coupling action is very simple. When two wagons fitted with the coupler come together the undermost link strikes faces which guide it on to and over the opposing draw hook. If the wagons are on a curve the link strikes side guides which bring the link and hook into line for engagement.

Pivoted on the link or shackle pin is a crank lever A (Fig. 2), formed of two plates riveted together. This crank is arranged so that it is struck up if the coupling link is lifted by means of the links and lever shown. The lifting of the link is effected by depressing short levers fitted on both sides of the wagons at the headstock. When the lever A is struck by the link and turned about its pivot, its short arm, which normally is level with the bottom of the draw hook recess, lifts the engaging link up to a level with the top of the draw hook, and the link pulls clear when the wagons are drawn apart. It is possible to set the coupling for this position so that wagons can be shunted together without coupling, or can be set for uncoupling to be pulled out later. The connection between the link and the lifting lever is flexible and provided with backlash, so that these parts do not interfere with the upward movement of one link when the other is passing beneath it to couple. The hand lever and lifting lever can be set, and also released, from either side, and the coupler will engage and uncouple easily on a three-chain curve.

In order to meet the requirements of the transition from the present loose link coupling, it is necessary that any new type introduced should be able to couple with the existing pattern. This is effected in the coupler we are describing by setting the link, from either side of the wagon, in an intermediate position. The lifting or short arm of the crank A is then so far below the top of the draw-hook that the engagement of a three-link coupling with it is possible. The actual coupling is performed by means of the usual coupling pole, the outside guiding cheeks of the Mackelson coupler being curved specially to facilitate this. It is thus unnecessary to pass between the buffers for this operation.

The setting of the link and coupler is accomplished by means of the hand levers referred to above and a catch bar which holds the levers in the desired position. This catch bar extends across the wagon under the headstock. It is arranged to slide a short distance to one side or the other, and at its ends is fitted with catches which engage with, and hold down, the coupler levers, which can be thus maintained in one position as long as the shunting operations demand.

The coupler is designed so that after the transition period a very similar pattern of fully automatic coupler with central buffing could be introduced. In this the link principle is retained, the chief difference being in the provision made for taking the buffing shocks on the head. This has been designed as a solid casting very much stouter than the present transition head, while the draw-bar is fitted, of course, with the requisite shock-absorbing gear.

The Mackelson coupler is manufactured by Messrs. George Turton, Platts and Co., Limited, of Savile-street, Sheffield.

PHYSICAL SOCIETY OF LONDON.

AT the meeting held on January 26, at the Imperial College of Science, Mr. Alexander Russell, M.A., D.Sc., in the chair, a paper on "*A Supposed Relationship between Sunspot Frequency and the Potential Gradient of Atmospheric Electricity*" was read by Dr. C. Chree, F.R.S., of which the following is an official abstract:—

In a recent paper in *Terrestrial Magnetism*, Dr. L. A. Bauer draws the conclusion that both the range of the diurnal inequality of atmospheric electricity potential gradient and the mean value of the element for the year increase and diminish with sunspot frequency. This conclusion was based on observational data from the Ebro Observatory, Tortosa, Spain, between 1910 and 1920. The present paper investigates the subject more mathematically, employing Kew electrical data from two periods of years, in addition to the Ebro data utilised by Dr. Bauer. Magnetic data from Kew Observatory for the same periods are similarly treated, so as to have parallel results from an element for which the sunspot relationship is generally admitted. The results obtained are on the whole not incompatible with Dr. Bauer's conclusion, but they indicate that if a relationship of the kind supplied exists, the sunspot influence must be very much less in the case of atmospheric electricity than in that of terrestrial magnetism.

Dr. A. Russell, in expressing the thanks of the meeting for an interesting and instructive paper, said that few realise the very high value of the potential gradient which normally characterises their physical environment, and which may have important biological effects, not only in connection with electro-culture but also in human psychology. The "correlation coefficient" which Dr. Chree introduced was not familiar to all physicists, and appeared to be of very great interest as a test of the inter-relation of different phenomena.

A paper on "*A Further Improvement in the Sprengel Pump*," by Mr. J. J. Manley, M.A., Research Fellow, Magdalen College, Oxford, was taken as read in the absence of the author. The paper relates to a further improvement in the pump described in the Proceedings of the Society, vol. xxxiv, page 86, which is designed to avoid irregularities due to air skins on the inner surfaces of the apparatus. The present improvement consists in means for providing a mercury seal during periods when the pump is out of use, whereby the formation of fresh air skins is prevented.

The third paper on "*Null Methods of Measurement of Power Factor and Effective Resistance in Alternate Current Circuits by the Quadrant Electrometer*" was read by Mr. D. Owen, B.A., D.Sc., F.Inst.P., Sir John Cass, Technical Institute, London. The abstract is as follows: Zero methods are proposed, and expressions derived, for the measurement of power factor and effective resistance of alternating current loads. The methods are extended to high tension circuits. The effect of "electrical control" of the needle of the quadrant electrometer is discussed, and it is shown that the usual formula for the instrument is applicable only when the needle is maintained at its mechanical and electrical zero. The further advantages of null methods are emphasised. Illustrative tests are recorded.

In the discussion which followed Dr. E. H. Rayner congratulated the author on his valuable additions to the many uses of the quadrant electrometer. This wonderful instrument was invented over half-a-century ago by Lord Kelvin, but was still unsurpassed in its utility, being applicable to the accurate measurement of power, insulation, phase-angles, and many other quantities. The speaker took the opportunity to point out some details as to which care is necessary in the practical use of the electrometer, and pointed out that with high voltages the mechanical force on the needle is considerable and may bend it, leading to inconsistent results at low power factors. An extremely important point when high voltages are applied to the needle is that the faces of the quadrants should be perfectly flat. To this end they should be ground on cast-iron after they have been fixed in place.

Mr. G. L. Addenbrooke referred to his papers published in *The Electrician* in 1901 as relevant to some of the points raised by the author. He had used deflectional methods because they permitted "seeing what was going on."

Dr. A. Russell congratulated the author on discovering so many theorems and applying them so usefully, and expressed appreciation of Dr. Rayner's helpful suggestions.

Captain R. Dunsheath (communicated): "This paper is very opportune at the present time when so many investigators are seeking the best method of measuring dielectric losses, and is full of useful suggestions. I do not agree with the author, however, that it is desirable to eliminate both voltmeter and ammeter. His methods give power factor only, but a figure for actual watts lost is generally required. Also, due to the importance of the dependence of power factor and losses on voltage, it is usual to decide at the commencement of a test what voltage shall be adopted, and a voltmeter is essential. The ammeter is not so necessary.

The author (in reply to the discussion): The remarks of Dr. Rayner will be valued by practical workers. The

question of phase error in the shunt resistance, and methods of compensation have also been treated by Orlich and Schultze. Mr. Addenbrooke's desire to follow what was going on by watching the deflection was, of course, quite natural. In reply to Captain Dunsheath's inquiry, the sensitivity of the electrometer used in the tests quoted was such that with 100 volts on the needle and one-tenth of a volt across the quadrants the deflection was about 60 mm. at a metre scale distance. This could have been multiplied three or four times possibly. Measurements on a $0{\cdot}01\,\mu F$ condenser could be conducted with much the same accuracy as those with $1\,\mu F$, since the resistance R could be increased in inverse proportion to the capacity.

A demonstration of an electro-capillary relay for wired wireless was given by Major C. E. Prince, O.B.E. The relay is intended for use with a calling device in connection with high-frequency currents acting as carrier waves for telephony over power mains. The high-frequency current is rectified and passed through a thread of mercury which is contained in a capillary tube, and is in contact at each end with a quantity of acid, platinum wires by which the current enters and leaves, being immersed in the latter. The passage of the current causes the mercury thread to move, and it was suggested many years ago by Wheatstone that this thread might be made to close an electric circuit; but practical difficulties prevented the successful application of the idea. In the present invention the capillary tube is arranged horizontally on a beam which, as soon as the mercury moves, overbalances in consequence of the weight of the latter and closes the circuit of a call bell or lamp. To prevent the evaporation of the acid the cups containing it are connected by a further capillary tube which serves to equalise the pressure, and the tube in which the mercury thread lies is widened at its middle point to form a chamber for the reception of bubbles and other obstructions which may have got into the tube before sealing.

The circuit arrangements make provision for the restoration of the mercury to its original position whether the call be answered or not. In series with the thread and with a rectifier is arranged a condenser in which the charge that has passed round the circuit is stored, and after the call this charge is sent through the mercury and acid in the reverse direction. The required discharge is effected by contacts which short circuit the rectifier when the switch hook is raised, but if the call be unanswered the same result is produced more slowly by a high-resistance leak. The instrument will respond to currents of 4 or 5 or even 2 microamperes, and will function during long periods without attention. Its sensibility was demonstrated by passing through it the voice current from the secondary of a microphone transformer, and subsequently the current from a single dry cell in series with the body of the demonstrator. If the leak resistance be small enough Morse signals will fail to effect a call in consequence of the leakage which takes place during the intervals between the signal elements, while a series of long dashes will nevertheless be effective and can be used as a call signal. The cause of the movement of the mercury is obscure, and the phenomenon is of some interest to physicists. The total movement appears to be proportional to the coulombs which pass, so that the arrangement might be used as a quantity meter for small currents, such as voice currents.

The Royal Sanitary Institute.—The ordinary general meeting will be held at the Institute on Wednesday, April 25, at 4.30 p.m. At the invitation of the Lord Mayor and City Council it has been arranged to hold the thirty-fourth Congress and Exhibition of the Institute at Hull from July 30 to August 4.

Transactions of the Institution of Naval Architects.—Vol. lxiv of the Transactions of the Institution of Naval Architects, which has now been issued, covers the proceedings at the spring meeting held in London in April last, and also those at the summer meeting held in Paris in July. The papers read at these meetings, which have all been dealt with in our columns, are reprinted in full with the accompanying illustrations, and also with the discussions on them. The volume includes lists of officers, representatives and members, and also gives the by-laws, regulations and other information relating to the Institution and its work. It has been edited by the secretary, Mr. R. W. Dana, and is sold for the Institution by Messrs. Henry Sotheran and Co., 43, Piccadilly, London, W.1.

Presentation of the "Joseph Sullivan" Medal to Mr. B. G. Lamme.—Mr. Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, was presented with the "Joseph Sullivan" medal by the Ohio State University on January 12 last. Prior to the presentation, Dr. T. C. Mendenhall, Trustee of the University and donor of the medal, spoke on Joseph Sullivan and his work, and after the acceptance of the medal an address was delivered by Dr. Elihu Thomson of the General Electric Company. Mr. Lamme, who graduated from the Ohio State University in 1888, is the first recipient of the medal, which will in future be awarded once in five years for an admittedly notable achievement on the part of a son or daughter of the Ohio State University, whether in science or literature. Ohio State University was on the occasion of the celebration of its semi-centennial presented by Dr. Mendenhall, emeritus professor of physics, with 3,500 dols. for the establishment of the medal. Mr. Lamme has been a prolific inventor. Most of the early rotary converter patents were in his name, and he is the father of the 60-cycle converter. The single-phase railway motor also stands to his credit, and he has contributed much to turbo-generator design and alternating-current apparatus generally.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—The more prosperous condition of the steel and engineering trades is being checked by the recent general advances in the cost of materials, brought about largely by the Continental situation. So far the Ruhr occupation does not appear to have influenced the well-being of our manufacturers to any great extent. Orders received which would otherwise have gone to Germany are counterbalanced by losses in business which would otherwise have been done with the Continent. The heavy branches have undoubtedly benefited by the trouble in Germany. Makers of pig-iron, steel billets and certain qualities of rolled steel report a substantial increase in sales, while lately the inquiries which have come to hand for these productions show a substantial increase. Foreign orders are increasing, and should the position become worse on the Continent substantial business should accrue to local steel-makers. The home demand for pig-iron is still in excess of the current output. Few of the works, however, are on full capacity, many furnaces being idle owing to the shortage in coke supplies. The steel trade is also suffering from a scarcity of scrap. Available supplies are eagerly snapped up, and although consumers are in many cases declining to purchase at the high rates demanded by holders the market has advanced over 20*s.* per ton since the middle of December. The advance in billets has been followed by increased quotations for wire rods and rolled mild steel. Derbyshire and Lincolnshire pig-irons have risen in price this week 5*s.* to 4*l.* 10*s.* per ton at the furnaces. In the cutlery trades, those who employ up-to-date methods are able to secure moderate business, but the whole trade is suffering inestimably from the American supply of cheap but second-rate goods. The pen and pocket knife trades are stagnant, the only bright spot being found in the scissor trade. Despite German activities there is here a decided improvement in business. There is nothing stable in the electroplate section; makers are awaiting developments.

South Yorkshire Coal Trade.—The South Yorkshire coal trade shows business fairly brisk. In steam hards there is an active demand both for the home trade and for export, and prices show a decidedly upward tendency. The demand from blast furnaces which have been restarted is substantial and railway companies are also taking increased supplies. Steel manufacturers complain of the higher rates asked for coal. On 'Change, some collieries were demanding 2*s.* per ton advance all round, and the general advances varied between 1*s.* and 2*s.* per ton. Cobbles and nuts are in brisk demand with prices firm. Slacks are still short, and for the better qualities rates have been advanced 1*s.* and 1*s.* 6*d.* per ton. Although home requirements are still below the normal for the season, house coal shows signs of an advance in prices. Furnace and foundry cokes are moving freely at firm rates. Quotations:—Best branch hand-picked, 32*s.* 6*d.* to 34*s.* 6*d.*; Barnsley best Silkstone 28*s.* to 30*s.*; Derbyshire best brights, 25*s.* 6*d.* to 27*s.* 6*d.*; Derbyshire best house, 23*s.* 6*d.* to 24*s.* 6*d.*; Derbyshire best large nuts, 20*s.* 6*d.* to 22*s.* 6*d.*; Derbyshire best small nuts, 15*s.* to 16*s.* 6*d.*; Yorkshire hards, 21*s.* to 22*s.*; Derbyshire hards, 20*s.* to 21*s.*; rough slacks, 9*s.* 6*d.* to 11*s.*; nutty slacks, 7*s.* 9*d.* to 9*s.* 9*d.*; smalls, 3*s.* to 5*s.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Trade.—Business in Cleveland pig-iron is on a very limited scale due to the extreme shortage of supply. Most producers can only entertain offers for March-April delivery, and for such business they report no difficulty in obtaining current quotations. Nominally, No. 1 is 110*s.*, and No. 3 is 105*s.*, but above these figures has been paid for small odd lots for early delivery. Siliceous iron is less scarce than are other kinds, and is selling at round about 107*s.* 6*d.* Very little No. 4 foundry is available for disposal, and parcels are realising 100*s.* and upward; No. 4 forge, mottled and white irons are not on the market at all.

Hematite.—There is much activity in hematite, the comparatively low prices of which are attracting more and more customers both on home and export account, and further advances are confidently looked for. Italy has been buying extensively and is still in the market to buy. Nos. 1, 2 and 3 East Coast brands are now fully 105*s.*

Foreign Ore.—Though actual sales of imported ore are still slow, inquiry shows improvement, and values tend upward. Best rubio is quite 24*s.* c.i.f. Tees.

Manufactured Iron and Steel.—The general state of the finished iron and steel industries is better than for a long time past. Contract books are well filled, and there is a steady flow of orders, so that prospects are quite bright. Demand for shipbuilding material is heavy, and rails are selling well to home and foreign customers, whilst producers of galvanised sheets can hardly cope with needs. Common iron bars are 11*l.*; iron rivets, 11*l.*; steel billets, 8*l.* 10*s.* to 9*l.* 5*s.*, according to quality; steel boiler plates, 13*l.* 10*s.*; steel ship, bridge and tank plates, 9*l.* 10*s.*; steel angles, 9*l.*; steel rivets, 12*l.* 7*s.* 6*d.*; heavy sections of steel rails, 9*l.*; fish plates, 13*l.*; and galvanised corrugated sheets (24-in. gauge, in bundles), 18*l.* 10*s.*

Imports of Iron and Steel.—Statistics issued this week show imports of iron and steel to the Tees from Holland, Belgium, France, Sweden, Norway, Germany and coastwise for the three months ending January 31 last, as compared with the same three months a year ago, and the corresponding pre-war period of 1913–14. The returns reveal that pig-iron received during the past three months amounted to 2,015 tons, as against 28,011 tons a year ago, and 50 tons in 1913–14; plates, bars, angles, rails, sheets and joists unloaded in the last three months are given at 3,312 tons, as against 938 tons a year ago, and 5,869 tons in 1913–14; and crude sheets, bars, billets, blooms and slabs imported in the last three months reached 19,763 tons, as against 14,704 tons a year ago, and 11,200 tons in 1913–14.

Blast-furnace Coke.—Furnace coke is extremely scarce and has sold at very high figures, but sellers are prepared to renew contracts with regular customers at round about 33*s.* 6*d.* for average qualities delivered.

Shipments of Iron and Steel.—The shipments of pig-iron, manufactured iron and steel from the port of Middlesbrough during January totalled 80,607 tons, as compared with 89,329 tons in December. Including the Skinningrove shipments, the pig-iron exports totalled 41,308 tons, as against 44,416 tons in the previous month, and of the former 14,767 tons went coastwise and 26,541 tons abroad. The shipments to America only reached 5,342 tons, whereas in December 22,450 tons were sent. Italy took 7,500 tons, Belgium 3,377 tons, Wales 3,464 tons, Scotland 2,902 tons, Denmark 2,802 tons and Germany 2,185 tons. The shipments of manufactured iron and steel totalled 39,299 tons, or a drop of about 5,000 tons as compared with the figures for December. India was the largest purchaser with 11,837 tons, and 10,326 tons were shipped to Australia.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scottish Steel Trade.—Despite the fact that a brighter tone is very general throughout the steel trade, business is still inclined to be a trifle slow. Plate mills have been going fairly well, but buying has not been as satisfactory as producers would like, although quite a moderately good business has been going through for sectional material. There is more plant in operation now than was the case a few weeks ago, and makers are looking forward to an early improvement in the demand. The recent stiffening up of prices was largely due to the increase in cost of production, and it is doubtful if producers are any better off. Black sheets are again more active, and quite a good number of orders are actually on the books, but whether or not the new range of prices will adversely affect business later remains to be seen. Export trade overall is beginning to show signs of getting better, but any increase in that direction is coming along very slowly. The following are to-day's market quotations:—Boiler plates, 12*l.* per ton; ship plates, 9*l.* per ton; sections, 8*l.* 15*s.* per ton; and sheets, $\frac{3}{16}$ in. to $\frac{1}{4}$ in., 11*l.* 10*s.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—There has been little change in the state of the malleable-iron trade of the West of Scotland during the week, and the latest advance in the prices has not had any very serious check on business. Orders already booked ensure steady running for some time and there is quite a fair day to day demand. Prices are firm with "crown" bars called 11*l.* per ton, delivered Glasgow.

Scottish Pig-Iron Trade.—Quite a good tone now exists in the pig-iron trade of Scotland and consumers are all more ready buyers. The general demand is fairly satisfactory despite the rising market, as all prices are tending upwards, and order books are well filled. Most of the current demand is on home account, and foreign buyers are not so much in evidence at present, one reason put forward for this being the higher prices now asked by sellers. Hematite iron is moving rather freely to the steel works.

Shipments of Scottish Pig-Iron.—The amount of Scottish pig-iron shipped at Glasgow Harbour during week ending Saturday, February 3, was 2,084$\frac{1}{2}$ tons, of which 1,937$\frac{1}{2}$ tons went foreign and 147 tons coastwise. During the preceding week the figures were 7,448 tons foreign and 160 tons coastwise, while during the corresponding week last year the totals were 471 tons foreign and 71 tons coastwise.

NOTES FROM THE SOUTH-WEST.

Cardiff, Wednesday.

The Coal Trade.—The shipping congestion which is still acute at the South Wales ports is seriously interfering with the export trade and handicapping colliery salesmen in the transaction of business. The railway company is unable to give the colliery companies a sufficient supply of empty wagons to keep pits working regularly, and the dock officials are unable to put enough boats in loading berths to absorb the maximum output of groups of collieries. The result is that though the majority of undertakings are fully sold temporary stoppages are frequent. An illustration of the effect of dock congestion on colliery working is afforded by the case of the Ellerman liner City of Marseilles. This vessel arrived at Cardiff to load 2,700 tons of rails for Calcutta and 2,400 tons of bunkers. Though the vessel was in port a week the Great Western Railway Company could not give her a berth to load the bunkers. As the steamer was scheduled to be in Glasgow on Monday last it was decided to sail her on the Friday night and that she should bunker at the Scotch port. The colliery which was to have supplied the bunkers was rendered idle for three days and about 630 men were thrown out of work. This notwithstanding the fact that the coal for the City of Marseilles was available, and in consequence a considerable number of wagons were held up under load and could not be returned to the pit. Yesterday the representatives of the coal trimmers and tippers on the

joint committee appointed to consider the employers' application for an extension of working hours, attended a meeting of the executive council of the South Wales Miners' Federation with a view to ascertaining what effect, if any, the congestion at the docks had on the working of the collieries. After hearing the reports the chairman of the Miners' Federation intimated that owing to the conflict of evidence submitted to them on the subject they would refrain from making any pronouncement, believing that the matter was one to be settled by the parties immediately concerned. That congestion is acute cannot be denied, for to-day there were 34 vessels waiting for loading berths at Cardiff, Penarth, Barry and Newport, of which 22 were at Barry. Meanwhile the undertone of the coal market is a little easier with respect to large coals but firm with regard to smalls. Most collieries are well booked up, but shipment difficulties make it possible for buyers, able to take quick delivery, to secure concessions varying according to individual circumstances. For best Admiralty large 29*s.* to 30*s.* is asked and for seconds from 28*s.* to 29*s.*, with drys from 26*s.* to 28*s.* 6*d.* Smalls of all classes remain in extremely short supply and steady on the basis of 21*s.* for best steams, 19*s.* for ordinaries, and 18*s.* for cargo sorts, while washed smalls range from 18*s.* to 23*s.* There is a good inquiry for coke. For inland purposes foundry coke ranges from 40*s.* to 42*s.* 6*d.* at ovens, and furnace from 27*s.* to 28*s.*, but for export the former commands from 45*s.* to 50*s.* f.o.b., and the latter 40*s.* to 45*s.* The patent fuel trade is still held up by the excessive cost of pitch, which has risen to 160*s.* Consequently fuel makers have withdrawn quotations as it is hopeless to expect to sell fuel at 10*s.* above the top price of best large coal. Already a number of the works have closed down and the shipments which are taking place, are on old commitments out of stock.

The Iron and Steel Trades.—The expectation of higher prices for raw materials has checked business in Welsh tin plates to some extent, as makers are not anxious to sell forward in view of the unsettled outlook. For standard boxes 21*s.* to 21*s.* 6*d.* is firmly quoted for prompt and forward business.

THE STANTON IRONWORKS COMPANY, LIMITED—The Stanton Ironworks Company, Limited, near Nottingham, are putting three further blast furnaces into operation on March 1. This will mean that they will be working 12 out of their 17 furnaces.

KING'S COLLEGE ENGINEERING SOCIETY.—The second anniversary meeting of the above society will be held in the theatre of the Institution of Electrical Engineers, on Monday, the 12th inst., at 5.30 p.m., when a paper on "The Development of the Electrical Supply Industry," will be read by Mr. C. H. Wordingham, C.B.E. The chair will be taken by Mr. F. Gill, president of the Institution of Electrical Engineers. Mr. Wordingham will deal especially with legislation and the commercial aspects of the electric supply industry.

DIESEL ENGINE USERS' ASSOCIATION.—This association has now issued a reprint of the paper on "Care and Maintenance of Diesel Engines," by Mr. George E. Windeler, which was read and discussed at two meetings of the Association in October and November last. The reprint reproduces in full the paper itself, the discussion and the author's reply, the whole covering 73 printed pages of foolscap size, all of which forms an interesting contribution to the literature on this type of engines. A copy can be obtained from the offices of the Association, 19, Cadogan Gardens, S.W. 3, at the price of 7*s.* post free.

PERSONAL.—On the retirement of Sir William Marwood, K.C.B., which took effect as from January 31, Mr. J. R. Brooke, C.B., has been promoted to be Secretary to the Ministry of Transport.—Messrs. R. and W. Hawthorn, Leslie and Co., Limited, state that they have opened a new office in Westminster, at 3A, Dean's-yard, S.W. 1. Telephone No. 2424 Victoria, and telegraphic address "Hawlesco Parl, London." The office will be under the supervision of Mr. Robert S. Rowell, one of their directors resident in London. Their city office at Exchange Chambers, 24, St. Mary Axe, will continue as heretofore.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held in the afternoon of February 5, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The deaths of Lord Kinnaird and the Hon. R. C. Parsons, members, and of Professor G. Lemoine and G. Lunge, honorary members, of the Institution, were reported, and resolutions of condolence with the families were passed. The special thanks of the members were returned to Dr. Ernest Clarke for his donation of 100*l.* to the fund for the Promotion of experimental research, and to Sir Humphry Rolleston for his gift of Sir Humphry Davy's honorary diplomas.

THE SIR JOHN CASS TECHNICAL INSTITUTE.—This Institute, of which the address is Jewry-street, Aldgate, E.C. 3, announces that a special course of lectures on "Copper and its Alloys" will be given at 6·30 p.m., during the Lent term, as follows:—Wednesday, February 14, inaugural lecture, "Some Modern Developments in the Industry," by Professor C. H. Desch; Wednesday, February 21, "Foundry Practice as Related to Copper Alloys," by Mr. H. S. Primrose; Wednesday, February 28, "Large Metallic Crystals," by Professor H. C. H. Carpenter; Wednesday, March 14, "Corrosion," by Dr. Guy D. Bengough; Wednesday, March 21, "Season Cracking and Heat Treatment," by Dr. Harold Moore.

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Friday, February 9, at 7 p.m., at the Royal Victoria Station Hotel, Sheffield, when Mr. S. E. Fedden, M.Inst.C.E., will read a paper entitled "Aerial Ropeways."

THE INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Special Conjoint Meeting with the Faraday Society arranged for February 9 is cancelled.

THE SOCIETY OF CHEMICAL INDUSTRY: CHEMICAL ENGINEERING GROUP.—Friday, February 9, at 8 p.m., at the Chemical Industry Club, 2, Whitehall-court, S.W. 1. Paper by Professor F. G. Donnan, F.R.S., on "Some Control Formulæ in connection with Leaching and Evaporating."

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, February 9, at 6 p.m., at Storey's Gate, St. James' Park, S.W. 1. Adjourned discussion on "Engine Indicators." Friday, February 16, at 6 p.m., at Storey's Gate, St. James' Park, S.W.1. Annual General Meeting. Paper by Mr. H. C. Young, on "Some Mechanical Problems in the Rubber Industry."

THE WEST BROMWICH ENGINEERING SOCIETY.—Friday, February 9, at 7.30 p.m., at the Technical School, West Bromwich, a paper on "Wireless Telephony" will be read by Mr. Howard Littley. Lantern slides and experimental demonstrations.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, February 9, at 7.30 p.m., at 39, Victoria-street. Hon. Members' Lecture, "The Effect of Temperature on the Properties of Engineering Materials," by Professor F. C. Lea, D.Sc. Friday, February 16, at 7.30 p.m., at 39, Victoria-street. Lecturette, "Notes on Some Insulating Materials," by Mr. T. L. Allison, Member. Saturday, February 17, at 2 p.m.: Visit to buildings in course of construction at Wembley for the British Empire Exhibition.

THE PHYSICAL SOCIETY OF LONDON.—Friday, February 9, at 5 p.m., Annual General Meeting of the Society at the Imperial College of Science, South Kensington, S.W. The General Meeting will be immediately followed by a Science Meeting. Papers to be read: (1) "The Eötvös Torsion Balance," by Captain H. Shaw, M.Sc., and Mr. E. Lancaster-Jones, B.A.; (2) A Demonstration of the "Flame Phone" (Scientific and Projections, Limited) will be given by Mr. H. W. Heath, B.Sc.

THE KEIGHLEY ASSOCIATION OF ENGINEERS.—Saturday, February 10, at 6.30 p.m., in the Assembly Room, Cycling Club, Cavendish Street, Keighley. Lecture: "Ball and Roller Bearings as Applied to General Engineering," by Mr. James Spiers.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Saturday, February 10, at 2 p.m., in the Lecture Theatre of the Institute, Newcastle-upon-Tyne. Discussion on "The Elimination of Power Losses and other Sources of Waste in Mines by the Use of Ball and Roller Bearings," by Messrs. K. C. Appleyard and A. W. Macaulay. Paper to be read, "Abstract of Recent American Coaldust Experiments," by Professor Henry Louis, M.A., D.Sc.

THE MINING INSTITUTE OF SCOTLAND.—Saturday, February 10, at 3 p.m., in the Heriot Watt College, Chambers-street, Edinburgh. Papers to be read and discussed, "The Mining of Two Seams in Close Proximity" by Mr. R. A. Macdonald. "Tests of Centrifugal Ventilators, with Special Reference to Initial Water Gauge," by Mr. Henry C. Harris; "Tacheometry as a Method of Underground Surveying," by Professor Henry Briggs, D.Sc., and Mr. James Cooper.

THE SURVEYORS' INSTITUTION.—Monday, February 12, at 8 p.m., in the Lecture Hall of the Institution, 12, Great George-street, S.W. 1. "The Law of Property Act, 1922," by Mr. C. P. Sanger, Barrister-at-Law.

THE ROYAL SOCIETY OF ARTS.—Monday, February 12, at 8 p.m.: Cantor Lecture, "The Vulcanisation of Rubber," by Mr. Henry P. Stevens, M.A., Ph.D., F.I.C. (Lecture II). Wednesday, February 14, at 8 p.m.: Ordinary Meeting, "The Durability of Refractories," by Mr. Walter J. Rees, Lecturer on Refractories in the University of Sheffield. Mr. H. J. C. Johnson, President of the Institute of Clay Workers, will preside. Friday, February 16, at 4.30 p.m.: "The Indian Census of 1921," by Mr. J. Marten, I.C.S., M.A., Census Commissioner for India. Sir Edward A. Gait, K.C.S.I., C.I.E., Member of the Council of India, will preside.

THE INSTITUTE OF MARINE ENGINEERS.—Tuesday, February 13, at 6.30 p.m., at 85–88, The Minories, Tower Hill, E.1, "Internal Combustion and Economy," by Mr. Tage D. Madsen.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Tuesday, February 13, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2, the following paper will be read: "Some Practical Notes on Oil Pumping," by Mr. G. W. E. Gibson, M.Inst.P.T. The chair will be taken by the president, Professor J. S. S. Brame, F.I.C., F.C.S.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, February 13, at 3 p.m.: Afternoon Lectures, Professor A. C. Pearson, Litt.D., on "Greek Civilisation and To-day: (1) The Beginnings of Science." Thursday, February 15, at 3 p.m., Professor B. Melville Jones, M.A., on "Recent Experiments in Aerial Surveying" (Lecture I). Saturday, February 17, at 3 p.m., Sir Ernest Rutherford, LL.D., D.Sc., F.R.S., on "Atomic Projectiles and their Properties" (Lecture I). Friday February 16, at 9 p.m., Evening discourse will be delivered by Professor A. V. Hill, O.B.E., D.Sc., F.R.S., on "Muscular Exercise."

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 13, at 6 p.m., at Great George-street, S.W. 1. Paper to be submitted for further discussion: "Wind Pressures and Stresses Caused by the Wind on Bridges," by Mr. Douglas Henry Remfry, Assoc.M.Inst.C.E.

THE JUNIOR INSTITUTION OF ENGINEERS: NORTH-EASTERN SECTION.—Tuesday, February 13, at 7.15 p.m., in Armstrong College, Newcastle. Mr. L. C. Edmondson will present a paper entitled "Notes on Shop Management."

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Tuesday, February 13, at 7.30 p.m., at The Rooms, 207, Bath-street, Glasgow. "Some Problems in High-Speed Alternators, and their Solution," by Mr. J. Rosen.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, February 13, at 7.30 p.m., in the Rankine Hall, 39, Elmbank-crescent, Glasgow. Papers to be read and discussed: "The Development of the Sulzer Engine," by Engineer Lieutenant-Commander L. J. Le Mesurier, R.N.; "Vane Wheels for Ship Propulsion," by Mr. Maurice E. Denny, C.B.E., B.Sc.; "The Application of the New Freeboard Regulations," by Mr. Alexander Chisholm, B.Sc.

THE INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Tuesday, February 13, at 7.30 p.m., in the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 38, Elmbank-crescent, Glasgow. Paper on "Some Phases of Lead Manufacture," by Mr. John A. Sillars.

THE INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Wednesday, February 14, at 7.30 p.m., in the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. Discussion.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Wednesday, February 14, at 7.30 p.m., at St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Paper by Mr. C. H. J. Day, on "Hydraulic and Electric Lifts." Mr. H. Baines, Chief Mechanical and Electrical Engineer, H.M. Office of Works, in the chair.

THE INSTITUTION OF GAS ENGINEERS.—Wednesday, February 14, at 3 p.m., at the Institution of Mechanical Engineers, Storey's Gate, Westminster. Conference on "Education in the Gas Industry."

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 15, at 6 p.m., "Some Problems in High-Speed Alternators and their Solution," by Mr. J. Rosen, Member.

THE INSTITUTION OF MINING AND METALLURGY.—Thursday, February 15, at 5.30 p.m., at the Rooms of the Geological Society, Burlington House, Piccadilly, London, the following papers will be submitted for discussion: "Liquid Oxygen in Mining," by Mr. Alfred James, Member (to be illustrated by lantern slides); "The Aneroid Barometer and Barograph in Engineering," by Mr. R. H. L. Lee, Associate.

THE INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Friday, February 16, at 7.15 p.m., at the University College, Singleton Park, Swansea. Paper on "Research and Industry," by Mr. F. C. A. H. Lantsberry, M.Sc.Tech.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, February 16, at Bolbec Hall, Newcastle-upon-Tyne, "A Review of Turbine Failures and their Causes," by Professor A. L. Mellanby and William Kerr.

FARADAY HOUSE ELECTRICAL ENGINEERING COLLEGE.—The annual examinations for a Faraday Scholarship of 50 guineas per annum tenable for two years in College and one year in manufacturing works, and for a Maxwell Scholarship of 50 guineas per annum tenable for one year in college and one year in works, will be held at Faraday House, on April 10, 11 and 12. Exhibitions may also be awarded to candidates who acquit themselves creditably in the above examinations. Further particulars may be obtained from the Secretary, Faraday House, 62-70, Southampton-row, London, W.C.1.

UNIVERSITY OF LONDON.—A course of four lectures on "The Control of the Speed and Power Factor of Induction Motors" will be given by Professor Miles Walker, M.A., D.Sc. (Professor of Electrical Engineering in the University of Manchester), at the Institution of Electrical Engineers, Savoy-place, Victoria Embankemnt, W.C.2, at 5.15 p.m. on Wednesday, February 21; Monday February 26; Wednesday, March 14; Wednesday, March 21. The lectures, which will be illustrated with lantern slides, are addressed to advanced students of the University and others interested in the subject, and admission is free, without ticket.

BUSINESS EFFICIENCY.—Although much time and thought has been expended by engineers and others in the increase of works economy and the improvement of production in the factory, the question of adopting improvements in office systems and the utilisation of modern labour-saving appliances has not, perhaps, received the attention that it deserves. The savings effected in the office are not always so clearly demonstrated as those in the works. With a view to interesting business people in this phase of efficient working, the Office Appliance Trades Association has organised an exhibition at the Central Hall, Westminster, which was opened on Wednesday, February 7, by the Postmaster-General, Mr. Arthur Neville Chamberlain, M.P. The exhibition will remain open until February 17, and affords a means of comparison of the many appliances and systems of working now available.

MULTI-CUTTING TOOL ARRANGEMENTS.

(*For Description, see Page* 163.)

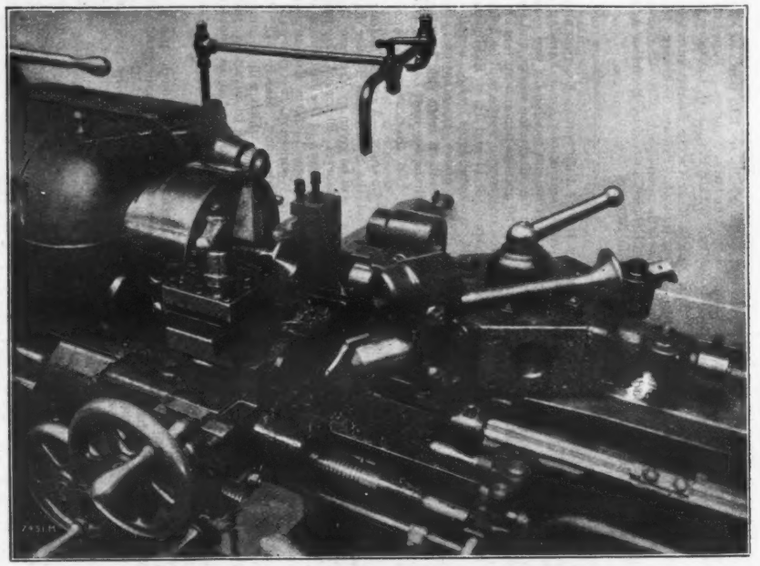


Fig. 61. First Operation on Aero Engine Valve.

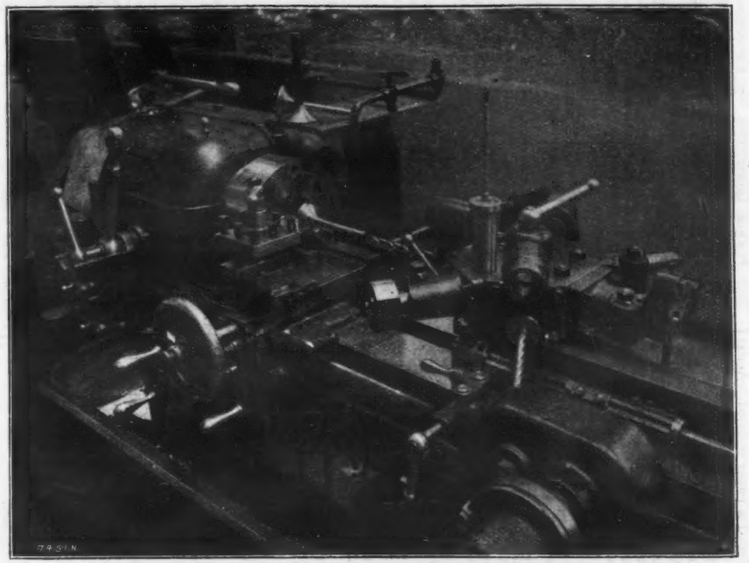


Fig. 62. Second Operation on Aero Engine Valve.

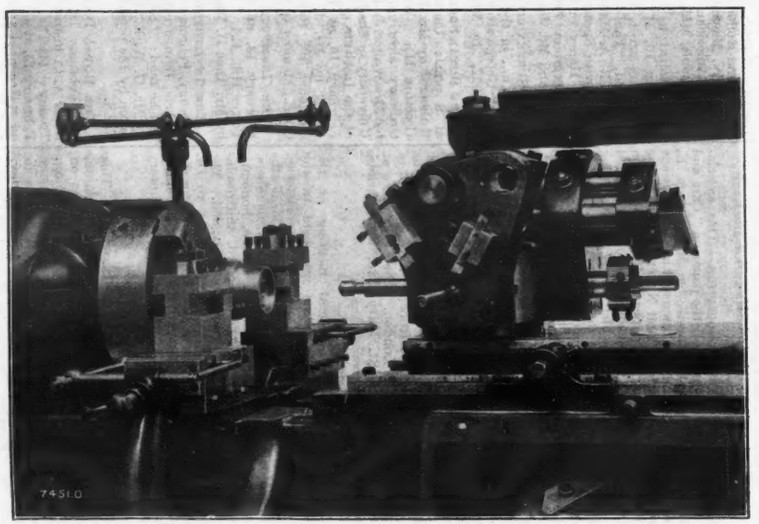


Fig. 63. Machining Motor-Car Hub in Automatic Lathe.

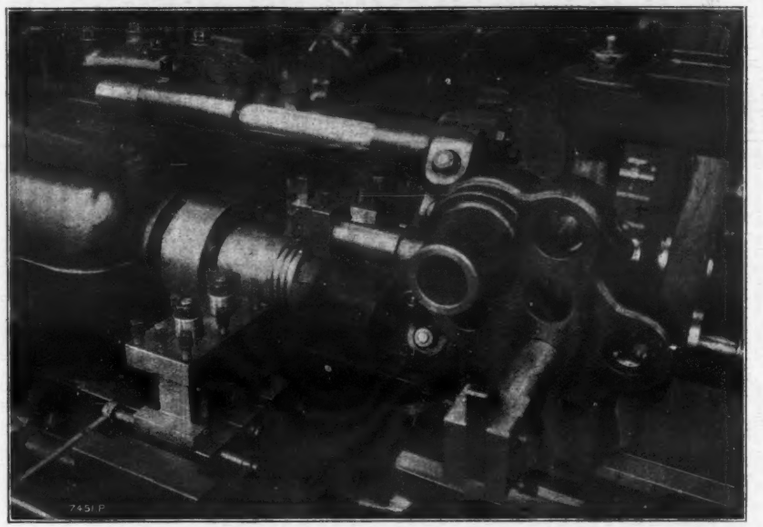


Fig. 64. First Operation on Gas Engine Piston.

DETAILS OF 18-IN. TELESCOPE AT THE NATIO

CONSTRUCTED BY MESSRS. T. COOKE AN

(For Description, see Page

Fig. 21.

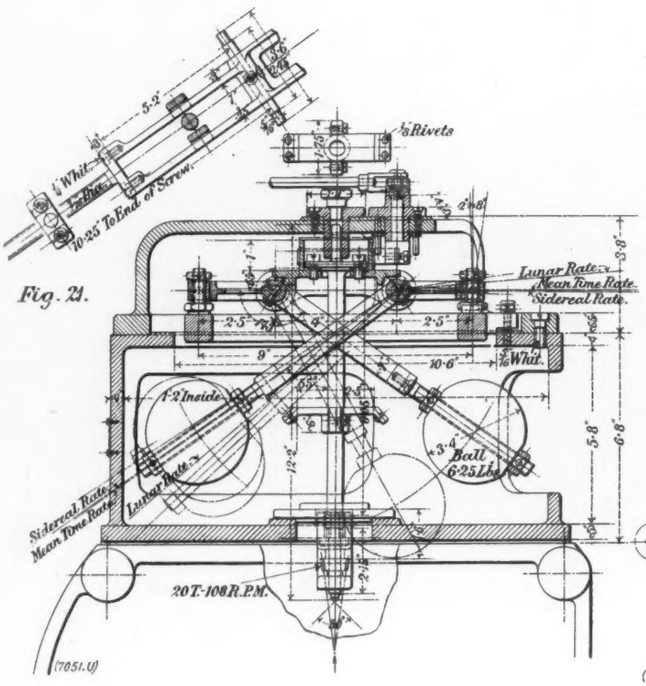


Fig. 22.

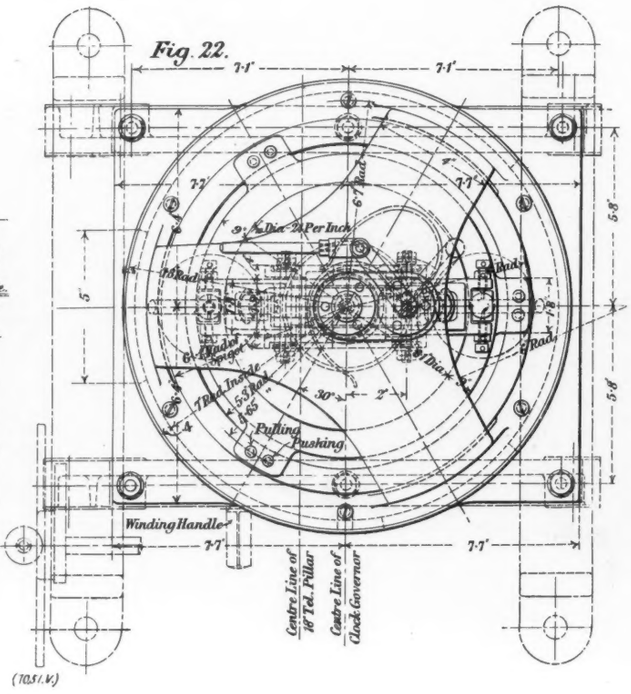


Fig. 26

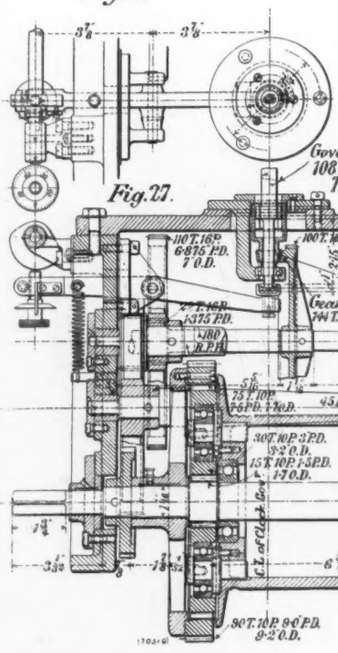


Fig. 27.

Fig. 28.

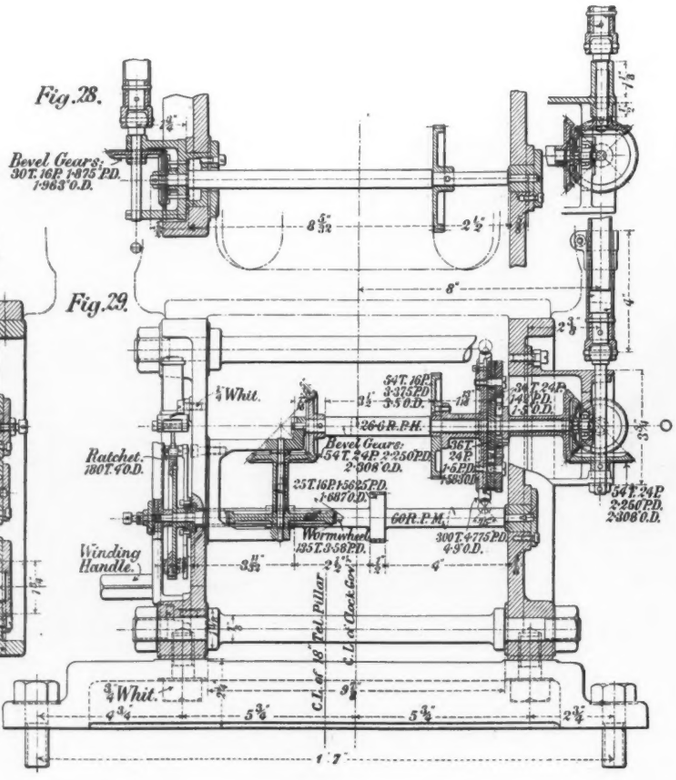
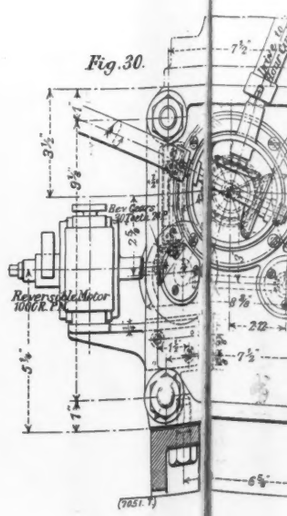


Fig. 29.

54 T. 16 P. 3·375 P.D. 3·5 O.D.
Whit.
36 T. 24 P. 1·5 P.D. 1·58 O.D.
266 R.P.H.
Bevel Gears. 54 T. 24 P. 2·250 P.D. 2·308 O.D.
36 T. 24 P. 1·5 P.D. 1·563 O.D.
25 T. 16 P. 1·562 5 P.D. 1·687 O.D.
54 T. 24 P. 2·250 P.D. 2·308 O.D.
66 R.P.M.
Wormwheel. 135 T. 3·38 P.D.
300 T. 7·75 P.D. 4·8 O.D.
Winding Handle.
C.L. of 18" Tel. Pillar
C.L. of Clock Gov.
Whit.

Fig. 30.



IE NATIONAL OBSERVATORY, RIO DE JANEIRO.

SRS. T. COOKE AND SONS, LIMITED, YORK.

(For Description, see Page 161.)

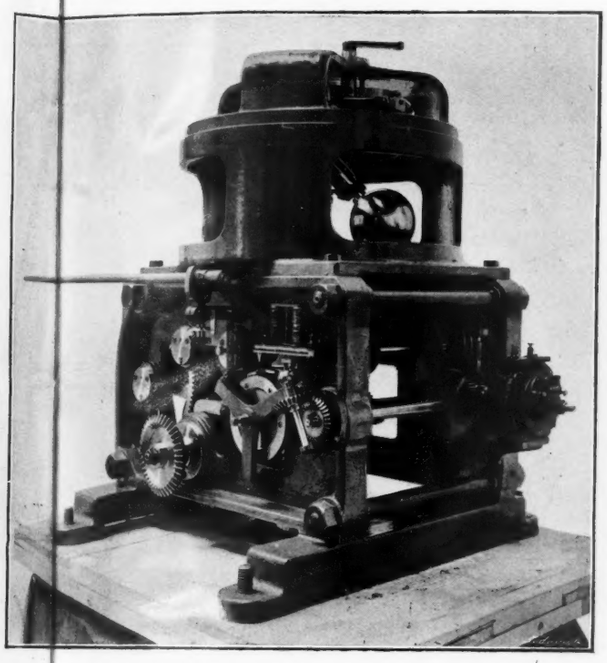
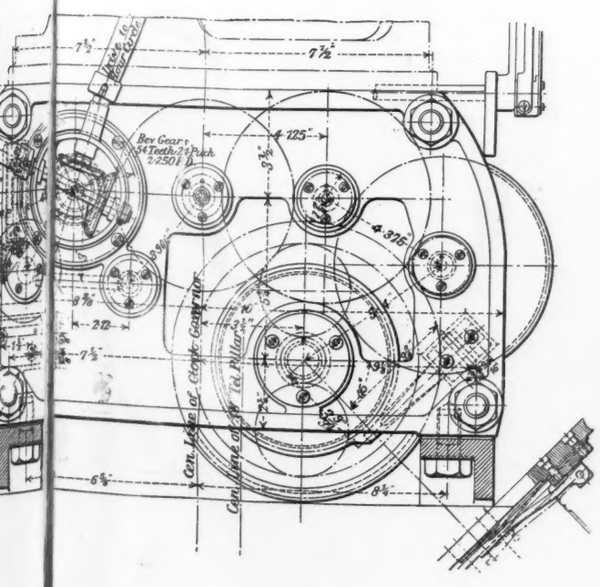


FIG. 23.



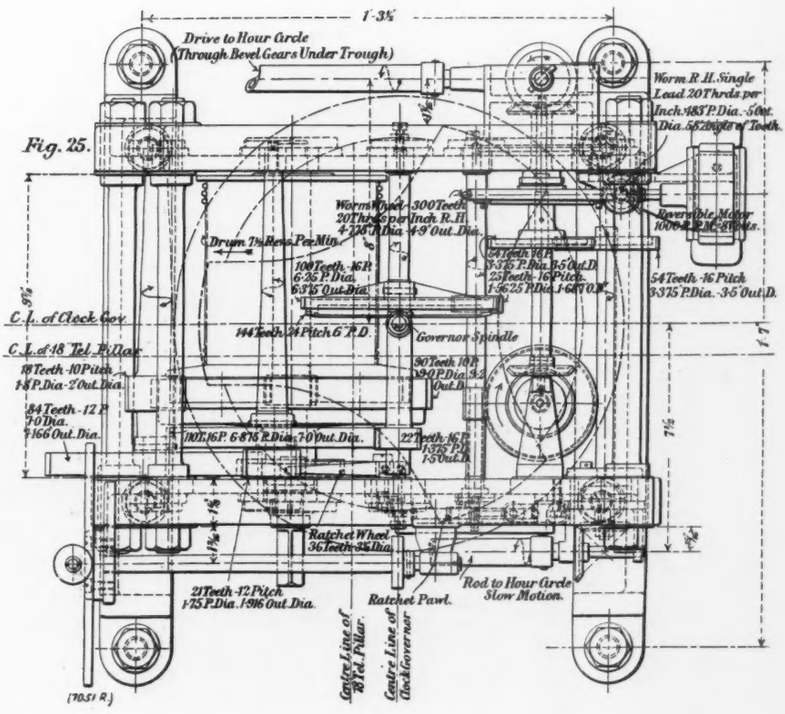


Fig. 25.
1'-3½"
Drive to Hour Circle (Through Bevel Gears Under Trough)
Worm R.H. Single Lead 20 Thrds. per Inch. 483 P.Dia. -50 Out. Dia. 56 Angle of Tooth.
Reversible Motor 1000 R.P.M. 60 Cycles
Drum 7½ Revs. Per Min.
100 Teeth. 16 P. 6·25 P. Dia. 6·375 Out. Dia.
24 Teeth. 16 P. 1·5 P. Dia. 1·625 P. Dia. 1·687 O.D.
54 Teeth. 16 Pitch 3·375 P. Dia. 3·5 Out. D.
C. L. of Clock Gov.
144 Teeth. 24 Pitch 6" P.D.
Governor Spindle
C. L. of 18 Tel. Pillar
18 Teeth. 10 Pitch 1·8 P. Dia. 2 Out. Dia.
84 Teeth. 12 P. 7·0 Dia. 7·166 Out. Dia.
110 Teeth. 16 P. 6·875 P. Dia. 7·0 Out. Dia.
22 Teeth. 16 P. 1·375 P. Dia. 1·5 Out. D.
Ratchet Wheel 36 Teeth. 3½ Dia.
21 Teeth. 12 Pitch 1·75 P. Dia. 1·916 Out. Dia.
Ratchet Pawl.
Rod to Hour Circle Slow Motion.
Centre Line of 18 Tel. Pillar.
Centre Line of Clock Governor
(7051 R.)

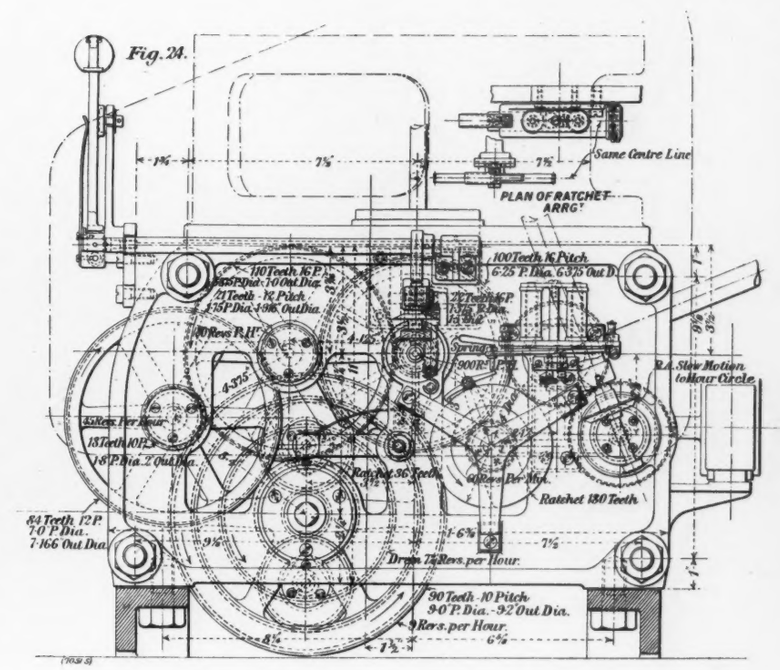


Fig. 24.
Same Centre Line
PLAN OF RATCHET ARRG.T
100 Teeth. 16 Pitch 6·25 P. Dia. 6·375 Out D.
110 Teeth. 16 P. 6·875 P. Dia. 7·0 Out. Dia.
21 Teeth. 12 Pitch 1·75 P. Dia. 1·916 Out. Dia.
40 Revs. P.H.
4·375
45 Revs. Per Hour.
13 Teeth 10 P. 1·6 P. Dia. 2 Out. Dia.
Ratchet 36 Teeth.
40 Revs. Per Min.
Ratchet 180 Teeth.
84 Teeth. 12 P. 7·0 P. Dia. 7·166 Out. Dia.
Drum 7½ Revs. per Hour.
90 Teeth. 10 Pitch 9·0 P. Dia. 9·2 Out. Dia.
9 Revs. per Hour.
R.A. Slow Motion to Hour Circle.
(7052 R.)

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ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C. 2.

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Two-Page Plate.—DETAILS OF 18-IN. TELESCOPE AT THE NATIONAL OBSERVATORY, RIO DE JANEIRO.

ENGINEERING.

FRIDAY, FEBRUARY 9, 1923.

THE PLACING OF CONTRACTS ABROAD.

THE resolution of the Council of the Institution of Electrical Engineers requesting those who place or who advise on the placing of orders to specify as far as practicable that the plant and material ordered shall be of British manufacture, reminds us that from time to time public opinion is aroused in this country by the news that some important contract for plant which British manufacturers were able and anxious to supply has been placed abroad. In times like the present, when unemployment is so serious in the country, incidents of this nature acquire a special prominence, and when, as is usually the case, the party awarding the contract is a municipal council or other public body, its action receives a wide advertisement by reason of the debates to which it gives rise. If ever the laws of economics become as well understood as most other natural laws, it may be possible to forecast the full results of any particular economic policy or action, and then the wisdom or otherwise of incidents such as those in question will be no longer a matter of dispute. At present, however, economic theories are innumerable, the shibboleth of one party being the heresy of another, and the views even of honest men are apt to be unconsciously coloured by sentiment, prejudice, or even by self-interest.

The ground of discussion may be cleared to some extent by eliminating those cases in which orders are placed abroad in spite of the fact that the requirements of the purchaser could have been better and more cheaply fulfilled by home manufactures. Instances of this sort are a good deal more frequent than might be imagined. Sometimes it is that the buyer simply does not know that the British product exists, or being aware of it, he is persuaded by an astute agent that it is inferior in quality to the imported variety or copy which it is the agent's business to sell. The remedy for conditions like these lies largely with our manufacturers themselves, who cannot expect their goods to be properly known and appreciated unless they adopt a selling policy as active as that of their competitors. They suffer in other cases from advice which buyers sometimes receive from those who pretend to exhibit a deep and comprehensive knowledge of the trade by advocating some particular foreign article of which the ordinary man has no experience. They have unfortunately sometimes, although we fancy the cases are rare, to meet an even more insidious form of competition from foreign firms who invite municipal officials and committeemen to inspect their works and to make a continental tour for the purpose of examining installations which they have carried out. Hospitality of this kind is apt to create a prejudice in favour of the firm which offers it, and the prospect of further trips to the Continent to report on progress or to witness official tests of the machinery cannot fail in some cases to have an effect when the award of contracts is under consideration.

When contracts go abroad in circumstances such as those we have mentioned, they have been lost by reason of competition which is unfair in the sense that considerations other than price and quality have affected the decision. The British manufacturer and the British consumer both suffer, one by a loss of trade and the other by having purchased less advantageously than he might have done. The facts being admitted, such contracts are indefensible, and there is no more to be said on the matter. Genuine argument, however, is possible concerning cases where there is a clear-cut issue on the matter of price alone. Many occasions arise when the British and foreign firms are both of high standing, their products being accepted as substantially equal in reliability and efficiency, their times of delivery both satisfactory and, in short, no material difference existing in their tenders except that of price. In such circumstances there can be no evasion of the issue. When the responsibility for a decision rests with a committee, the usual result is that after the outpouring of a considerable amount of very questionable economics the contract is awarded in accordance with the sentiments or political prejudices of a narrow majority. If it is placed abroad, the opposition party raise a protest which would be much more sincere if its members could individually affirm that never under any circumstances did they buy foreign-made articles for personal or domestic use, if British-made ones were available.

There is everything to be said for the view that a man when acting on behalf of the public should make his decisions exactly as if his own interests, and not those of the public, were at stake. If we may assume that men on committees do act as they would do in connection with their own affairs, it would be somewhat difficult to form a committee, even exclusively composed of British manufacturers, who would not at times place an order for machinery outside the country, on the sole grounds that it could be purchased more cheaply from abroad. There are very few British engineering works where foreign machine tools of one sort or another are not to be found, and this is true even of tool-making establishments. The same sort of thing extends to other articles. British firms are now ordering from abroad such typically British products as steam engines and boilers, and we believe that several large steam turbines of German manufacture have recently been purchased for this country. Under such circumstances there is a want of logic on the part of those who demand that public contracts shall never go abroad while maintaining that "business is business" as regards private ones.

All questions of international trade, and the placing of contracts abroad is one of them, must be regarded in the light of the peculiar position of this country. The population of these islands can only be fed and clothed by means of our imports, and these will only be sent us in exchange—usually in round-about fashion—for an equivalent amount of exports. If we refused to import anything but food-stuffs and raw materials, which is the ideal of some people, two broad results would follow. Firstly, we should put up the price of foodstuffs and raw materials in the world-market because we would accept nothing else in payment for our manufactures, and secondly, we should have great difficulty in disposing of the latter abroad, except

to such countries as were the natural suppliers of raw material. Moreover, foreign manufacturers would try to undersell us in such markets, in order that they might obtain raw materials and foodstuffs not only for their own use, but also to use as a medium of exchange with us. The net result would not be advantageous to us, and even were the policy not pushed to the extremes we have supposed, it would still have a prejudicial effect.

The antithesis of this policy, which has been advocated by a powerful political party, consists in freeing trade from artificial constraints of every kind, the argument being that the sum of the unrestricted self-interests of the population would naturally direct trade along those lines which would be most beneficial to the country at large. If material wealth were the criterion of national success, there would be much to be said in favour of this contention, especially if the flow of our trade were conditioned entirely by natural causes. But other nations have their own ideas, and by placing restrictions upon their imports from us or subsidising their own exports they have the power, very noticeably to influence the nature of our activities. It is an open secret that before the war there were powerful foreign organisations at work to prevent the adequate development of important industries upon which our national security might depend. Heavy forgings were sold in this country at prices considerably below the cost of manufacture, in order that our own forges might have no chance for development. It is indeed common knowledge that many industries essential to our safety had to be started and built up after the great war had commenced. This dangerous state of affairs was the natural consequence of a too slavish adherence to a particular economic creed. A further drawback was the undoubted fact that we were becoming more and more dependent upon trade rather than upon manufacturing, and such things as we exported most largely were becoming of a nature to give employment mainly to a low average quality of labour. The population did not include nearly so many instrument makers, chemists or other highly-skilled and highly paid craftsmen as it should have done, but comprised an undue proportion of men engaged in low-paid clerical work or heavy labour.

To what extent a nation is really benefited by interfering with the natural flow of its external trade by means of tariffs or legislation we do not propose to consider. This is a question in economics still unsolved, and one which probably never will be solved to the satisfaction of all parties. To the ordinary person it is a matter which, though possibly provocative of heated discussion, does not call for any personal decision except perchance at the time of a general election. With the placing of contracts it is different. A decision has to be arrived at, and the merits of the case have to be very carefully balanced. Supposing a municipal contract is involved and a foreign tender is the lowest, the question takes the form of whether the sadly overburdened ratepayer shall be still more heavily burdened in order that the work may be kept at home. It may be argued that if the foreign tender is ignored, British prices will never be lowered to a competitive level, and until they are forced down, the British manufacturer will be even less able to compete abroad than he shows himself able to compete at home. On these grounds the acceptance of the foreign offer would act as a wholesome, if unpleasant, tonic for the British maker. Medicine of this kind is indeed necessary when the purchaser is confronted with a number of British tenders all identical in price and terms, and all, of course, higher than foreign ones. People who will not abide by the rules of a competition must not grumble if they find themselves left out of the game.,

Such cases, however, do not often occur. At the present time contracts are so difficult to get that it may be fairly assumed that the prices quoted by British makers are the lowest possible for them to offer. Were there a greater volume of work going through their shops, they could quote more favourably, and in many instances their prices will be brought down more effectively by placing orders with them than by withholding them. Purchasers, whether individual buyers or municipal bodies, who place contracts abroad at the present time incur a serious responsibility. Against the saving of a few hundreds of pounds in first cost there has to be offset the maintenance of the men who might otherwise be working, and the blow to the prestige and interests of the manufacturers of this country. It is a serious and a pitiful thing that hundreds of thousands of men anxious to work, should remain in enforced idleness as at present. Their small savings are dissipated, their homes broken up and from being self-respecting and independent citizens they are driven into the ranks of the corner loungers, maintaining a miserable and useless existence on doles from the taxpayers. It is hard, indeed, for such men to recover their former position and outlook, and the loss to the nation by the depreciation of their character and skill is incalculable. These are the intangible results of acute trade depression, and those who have contracts to place are in duty bound to consider whether the urgent necessity of getting the wheels of industry revolving again in this country does not outweigh the temporary advantage of purchasing more cheaply abroad. Prosperity can only be regained by everyone working hard to restore the wealth lost by the war, and until we can get the nation at work again all other industrial questions are of minor importance.

AUTOMATIC SUBSTATIONS.

One of the common arguments in favour of alternating current distribution and operation as against direct current working is that static substations, requiring no attendance, may be employed. The argument is commonly brought up by the advocates of alternating-current traction, and the expense of the staff required for the rotary substations is put forward as one of the weaknesses of the opposition method of working. The relative importance of an item of this kind in a complicated matter like the generation and distribution of electricity cannot, however, very profitably be discussed in general terms, and the item must be given its proper place in the examination of the details of any scheme. This matter of the cost of substation attendance may nevertheless take on an added importance as a distribution or traction system grows in extent, and while it may be of little importance in connection with a dense urban traffic system such as is represented by the London underground railways, it may grow almost to a determining factor when branch lines are thrown out into thinly populated districts.

The matter has come up in a very definite way in connection with direct-current traction systems in America, and has been met by the installation of automatic rotary substations on an extensive scale. Such stations, which are used in connection with general distribution as well as on traction systems, contain rotary machines which automatically start up or shut down, as the state of the local power demand may direct. There are, we believe, some 400 of such automatic substations in America. In many cases they are on out-of-the-way branches of traction systems, the station starting up when the infrequent trains come along, and closing down again when they have passed. Similar conditions to this are probably not very usual in this country, but there are cases in which the qualifications of the automatic rotary substation should be of great value, and a start has been made in the employment of such stations in England by the Electric Supply Department of the Corporation of Liverpool, which has built a 500 kw. rotary converter full automatic substation for general power and lighting supply. The station is operated from 6,000-volt three-phase mains, and feeds a three-wire system with 460 volts across the outers.

The station is situated in a residential area that has grown rapidly in recent years, and in which the increasing load had caused the voltage drop in the feeders to become the factor determining further extension of the load. The size of the mains allowed of considerably increased currents being carried, as in some cases the current-carrying capacity was only utilised to the extent of about 30 per cent. As the trouble was entirely due to voltage drop it could be rectified by the introduction of new feeding points, and the question of laying new feeders from existing substations in the neighbourhood was considered. This method, however, did not cover any very satisfactory possibility of further growth of load in the future, and it was finally decided to build a new substation to supply the neighbourhood. Consideration of an automatic station as against a station of ordinary type with attendants showed a saving of some £1,000 a year in favour of the automatic arrangement, and it was accordingly adopted and is in very satisfactory operation.

This automatic station is, of course, of small size, but the confidence which its behaviour up to the present is likely to inspire may be expected to lead to a considerable extension of the system and its application in larger units. The Corporation of Liverpool is already building a second similar station. This development represents merely another of the labour-saving refinements of machinery which are being forced on by present conditions. The station is in a sense complicated, in that the automatic gear involves a large number of relays and similar appliances, but there is no reason to suppose that modern gear of this kind properly housed and maintained is likely to give any trouble, or to prove other than entirely reliable. Electrical gear of a not greatly dissimilar type has been utilised in connection with electric signalling and similar work in much more unfavourable situations than a well-maintained substation, and has proved quite satisfactory. A description of this automatic substation at Liverpool was contained in a paper read before the Institution of Electrical Engineers on the 1st inst. by Mr. P. J. Robinson, who gave a very clear explanation of the somewhat complicated automatic switching arrangements, and explained the financial and technical considerations which had led to the installation of this pioneer plant.

TANK TESTS OF SEAPLANE MODELS.

While the main object of a seaplane or amphibious aircraft is to travel through the air as safely, rapidly and economically as possible, an essential factor in the attainment of that object is that the craft should be able to travel over, rise from and alight on the surface of the water under all conditions likely to be encountered. The production of an efficient and reliable aircraft of the type referred to, especially if of large dimensions, therefore involves the solution of some intricate problems in naval architecture, as well as those of aerodynamics and structural engineering. As in other branches of naval architecture, useful help in overcoming the difficulties encountered in the development of seaplanes and amphibians has been obtained from tank experiments on models, and in an interesting paper read before the Royal Aeronautical Society on Thursday, the 1st inst., Mr. G. S. Baker explained what had been done in the William Froude National Experiment Tank at the National Physical Laboratory, in the course of the ten years during which this class of work has been carried on there.

The first tests, commenced in 1912, were made to determine the lift and resistance of flat planes skimming on the water, and these were followed by tests on floats of various forms. Much useful information was obtained, and a seaplane fitted with floats designed in accordance with the results of the tests was found to get off the water at three-fourths the power required to get off with an earlier form of float. Improvements in the testing apparatus and methods of testing followed, leading to greater accuracy in the data obtained and bringing the conditions of the experiments more nearly into line with working conditions on the full-size machine. Many forms of boat-type hulls have since been generally examined and compared, and effects such as wave-making, nose diving, porpoising, &c., have been fully investigated; the study of longitudinal stability, it may be remarked, has now advanced sufficiently to enable the tendency to porpoise, which formerly gave much trouble, to be greatly reduced and sometimes completely eliminated in smooth water. Careful consideration has, of course, been given to the application of the results of model experiments to full-size machines, and every possible opportunity taken to check this by measurements on the latter. In predicting results for machines from data obtained from models, it is assumed that moments, forces and speeds vary as the fourth

third and half powers, respectively, of the relative scales.

This assumption neglects the effects of possible differences in the relative values of skin friction resistance, but there are good grounds for the belief that the procedure employed gives correct results at high speeds, while at low speeds the calculations for the power required are rather too high. It is thought, however, that the errors involved are largely balanced by adverse sea and weather conditions met by the machine. Some interesting and important experiments in this connection were carried out in 1918 by towing a seaplane, by means of a destroyer, at speeds up to 20 knots, and also running the machine under its own power at speeds up to 25 knots. The results, in general, were in good agreement with calculations. Discrepancies have, however, been found in connection with the running angle at high speeds, the angle being some 3 deg. smaller in the machine than in the model; this difference is now recognised as being due to the effect of the air structure of the machine. The theory and practice of testing seaplane models in the tank has thus reached a stage when it is of immediate utility to the designer—especially to the designer of large machines for which data of the greatest possible accuracy is required. In Mr. Baker's opinion such large machines will be needed in the future by this country in particular, and he rightly remarks that the research work necessary for their development should not be deferred.

THE FOUNDATIONS OF WIRELESS COMMUNICATION.

AT the present time when direct communication between this country and Australia by wireless telegraphy is possible, and speech has been transmitted across the Atlantic by similar means, the feeble efforts which the early experimenters were able to produce and detect over a distance of a few yards seem very far from impressive, even to those familiar with them. Actually the majority of those who are now interested in wireless communication for business or pleasure are quite unaware of the stages through which this fascinating branch of applied science has been carried in order to pave the way for modern achievements, but that some, at least, of them are anxious to learn may be gathered from the attendance at a lecture delivered at the Finsbury Technical College, on Thursday, the 1st inst., by Sir Oliver Lodge. The meeting, which was presided over by Sir Charles A. Parsons, was arranged in honour of the memory of Professor Silvanus P. Thompson, the late principal of the college, who at the time of his death in June, 1916, had been connected with the institution for upwards of thirty years. Sir Oliver chose as his subject "The Basis of Wireless Communication," and in the course of his lecture referred briefly to the outstanding features of the pioneer work carried out prior to 1896.

After mentioning some early observations by Joseph Henry in 1842 and by Edison in 1875, Sir Oliver referred to the work of David Hughes, remarking that the latter was nearly on the track of what was subsequently discovered by Hertz. In the early 'eighties, by means of sparks, Hughes obtained effects akin to coherer action of sufficient strength to deflect a galvanometer, but was rather discouraged by Stokes, who thought the effects might be explained by leakage. The foregoing, the lecturer remarked, were mere spasmodic observations, and he ascribed the first step in real discovery to Clerk Maxwell, who, in 1865, gave the laws of electric waves in mathematical form. Sir Oliver mentioned that he had discussed the matter with Professor Fleming in 1872 and later with Fitzgerald, who had at first concluded that the production of electric waves was impossible but had corrected the erroneous impression in 1882. The following year, at the Southampton Meeting of the British Association, Fitzgerald suggested that the oscillatory discharge of a Leyden jar might be used for the production of electric waves if means for detecting them could be devised. A few years later the lecturer himself found that waves could be both produced and detected by means of Leyden jars. He also succeeded in measuring the wave length and in obtaining the phenomenon of electric nodes and loops, thus verifying Maxwell's theory.

Afterwards the lecturer heard of the brilliant experiments of Hertz, who produced and detected waves in space, using as a detector a ring of wire containing a minute spark gap. Hertz, however, was not fully acquainted with Maxwell's work and did not make use of the words "electric waves" in describing his experiments. He had, however, worked out the subject with extraordinary skill both mathematically and experimentally, and the lecturer regarded Maxwell and Hertz as the essential founders of wireless communication. Actual telegraphy was subsequently made possible by the coherer, the development of which the lecturer described, dealing very briefly with his own important contributions to this part of the subject. He mentioned, however, that the fact that some of his work had been published in 1894 prevented patents from being granted in this country, although they were obtained in the United States, and added that these patents, which were subsequently handed over to Mr. Godfrey Isaacs, formed the fundamental patents of the American Marconi Company. In conclusion, Sir Oliver remarked that he had been too busy, and had lacked the foresight necessary to realise the full possibilities opened up, but fortunately there had been a man in Italy with sufficient insight to see, and leisure to develop, them. In 1896, Senatore (then Mr.) Marconi came to this country and the subsequent developments, the lecturer said, were public knowledge.

THE RECOVERY OF IRON AND STEEL FROM OVERSTRAIN.

IT has long been known that overstrained bars of steel and iron have the power of automatically recovering their elastic properties if left unloaded for a long period of time. It is possible that this mechanical Couéism plays a rôle of some importance in the case of statically indeterminate structures, such as rigid arches, which are often subjected to somewhat severe temperature stresses in countries enjoying a Continental climate, with its characteristic extremes of heat and cold. In rolling mills it has, moreover, been noted that the physical properties of steel rails, as determined from specimens cut from the rail immediately after rolling, differed decidedly from those observed with specimens prepared a few days later. Some thirty years ago, Sir Alexander Kennedy commenced a systematic inquiry into this matter of the auto-recovery of structural materials, and obtained some interesting and striking results. The investigation in question extended over the years 1886 to 1893. The plan followed was to record the extension of bars of iron and steel, under loads increasing by increments of 2,000 lb. to 4,000 lb. each, until the total stress was well in excess of the yield-point. The extensions were measured by a micrometer reading to $\frac{1}{10,000}$ in., the gauge length being 10 in. Control specimens of the same material which had never been subjected to test were kept for the purpose of comparison, when the overstrained bars were re-tested after a rest of some years' duration. As already stated, Sir Alexander Kennedy's own observations ceased in 1893, but he recently handed over his specimens to the Research Department at Woolwich, who have completed the investigation. The work in question was carried out by Mr. R. H. Greaves, B.Sc., whose report* will be found of much interest.

Mr. Greaves' experiments showed that during the thirty years which had elapsed since the original experiments, the overstrained specimens of iron and of soft steel had completely recovered their elasticity, but with the hard steel specimens the recovery had made but slight progress. The recovery could, however, it was found, be rendered complete by heating the hard steel bars to a temperature of 175 deg. C for 1 hour. In the original experiments some of the bars had been kept under overstrain until stretching entirely ceased, whilst in other cases the overstrain was produced by a momentary load. On re-testing thirty years after, these latter specimens were found to have an elastic limit less than the original overstrain, whilst in the case of the slowly-loaded bars the new elastic limit exceeded the stress by which the overstrain had been produced. The unstressed specimens were also examined, and experiments made to determine the rate at which they recovered from an overstrain. The criterion used was the presence or absence of a hysteresis loop. With a perfectly recovered specimen the extensions were the same on loading as on unloading, but where recovery was incomplete there was a loop, the width of which was a gauge of the amount of overstrain still existing. It was found that this criterion was more sensitive than that adopted in the original experiments where the absence of permanent set was regarded as showing that the elastic properties of the bar had been restored. In the new experiments it was found that in certain cases a hysteresis loop might exist even when there was no permanent set.

One curious fact observed was that when very slowly loaded beyond the elastic limit, wrought iron extended less for a given maximum load than when the latter was momentarily applied. With alloy steels the reverse is the case. The explanation proffered is that with wrought iron the rate of automatic recovery is so great, that it goes on even when the specimen is still under an overstraining load, provided that this load is applied at a very slow rate. With steels the rate of recovery is slower, the harder the steel and the greater the original overstrain the longer is the time required for recovery. Even the hardest steels, however, show some degree of recovery, though at ordinary room temperatures the rate of restoration is very slow. In the case of a crucible steel (1·22 C.) the recovery was in thirty years about as much as would be brought about by keeping the specimen for 1 hour at a temperature of 100 deg. C., and considerably less than if the bar were kept for 60 minutes at 125 deg. C.

* R. D. Report No. 54. *Recovery of Elasticity by Iron and Steel after Overstrain.* H.M. Stationery Office. 2s. 7d. post free.

NOTES.

THE PROGRESS OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

ALTHOUGH the speeches which form an apparently essential item in the programme of any annual dinner can hardly fairly be expected to address themselves to any common text, there was a distinct unity in much that was said at the gathering of the Institution of Electrical Engineers which took place at the Hotel Cecil on the 6th inst. The text may be said to have been the progress of the Institution and the increasingly important position which it is taking in technical and even national affairs. The more laudatory references to the subject naturally fell from the guests, and both Sir W. Joynson-Hicks and the Right Hon. Neville Chamberlain paid tributes to the work of the Institution and the progress with which it is closely associated. The Institution now has 10,600 members and shows an increase of 3,000 in the last four years. This progress has not been attained by any relaxation of conditions of entry, and by far the greater part of this total number entered by examination as students. This is the normal and natural course, and shows that the Institution to an increasingly greater extent is able to speak with an authoritative voice for the profession for which it stands. The Institution was one of the first to encourage local sections, which now form an essential and valuable feature of its activities, and a new local section has just been formed at Liverpool, which up to the present has existed as a sub-centre of the Manchester branch. It is to be hoped that the great authority and influence of the Institution will be bent to assist towards a better and more economical generation of electricity in the country. Mr. Gill, the President, in his speech, pointed out that 43 per cent. of our electric supply stations have an output of under one million units a year. The new Electricity Bill is intended to improve this state of affairs, but much opposition has yet to be faced and much arranging has to be done, and the Institution should be able to assist materially if its influence is brought to bear properly.

DIESEL-ELECTRIC SHIPS.

Some interest is being taken in the Diesel-electric drive, especially for ships of moderate power, and several applications of this method of propulsion have been made in America. The advantages which

may be claimed for this combination as compared with the direct Diesel drive are of the same order as those which are claimed for the turbo-electric plant against the geared turbine. The Diesel engines can be of a high-speed type, since any suitable reduction may be arranged between their revolutions and those of the propeller; further, the engines require no reversing gear and can be built as moderate-sized units, since there is no difficulty in arranging that two or more engines shall drive a single propeller motor. This arrangement adds to the safeguards against a total breakdown as far as the engines are concerned, but it is clear that the method cannot be carried too far, and that an immoderate number of generating units is not likely to find acceptance in marine circles. This last condition limits the profitable use of the method to ships of moderate power, so that if the system is to be applied on any considerable scale it will have to make a case against the ordinary direct drive Diesel arrangement which is coming into use so extensively. In a paper read before the Liverpool Engineering Society, on the 7th inst., under the title "Electric Propulsion of Ships," Mr. R. S. Johnson gave a worked-out comparison between the two systems as applied to a 3,380-ton, 325 ft. ship. Camellaird-Fullagar oil engines were assumed, of a total horse-power of 2,500. For the direct drive ship a twin-screw arrangement was assumed and a single-screw for the electric scheme. The figures showed a fuel consumption, excluding that required for refrigerating machinery, of 11½ tons per day for the direct drive ship and 12½ tons per day for the electric ship. Consequently the electric ship had an oil bunker capacity of 320 tons against 290 tons for the direct drive ship, but had an increased cargo capacity of 5,000 cub. ft. The extra consumption of the electric ship is thus covered by the larger bunker capacity, and therefore each ship would be able to run about the same distance without re-bunkering, so that the comparison comes down to the balancing of an extra ton of fuel oil per day against an extra cargo capacity of 5,000 cub. ft. It will be clear that the Diesel electric drive can make no sweeping claims on the score of Mr. Johnson's comparison, and if he accurately represents the qualifications of the two systems those who object in principle to the introduction of the electric gear are not likely to weaken in their opposition in the near future.

Electric Resistance Furnaces.

In the generation of heat for laboratory purposes and for those industrial processes where constant temperatures are essential, electricity possesses advantages over other methods both in cost of running and in cleanliness. The cheapness of electric heating is due to the fact that there are not produced hot flue gases, which carry away a large proportion of the heat, and the cleanliness is an effect of the same cause, for in most cases of fuel-heated furnaces the gases contain constituents which contaminate the product. A review of the present position and the possible extension of use of the electrical resistance furnace was provided in a paper on the subject read by Mr. Charles R. Darling, at the Royal Society of Arts, on Tuesday last. The first form of this type of plant was introduced for use in laboratories in 1902 by Hercæus, but until 1907, when the nickel-chromium alloys used for the coils in modern resistance furnaces were available, their use was limited to very small units. From that date there was a marked increase in development. The nickel-chromium alloys, put upon the market under many trade names, may be heated for long periods at 1,000 deg. C. without either oxidising or other deterioration, and have another useful property in offering a resistance to the flow of electricity which is nearly constant at all temperatures. The immediate effect of the discovery of these alloys was that small tube furnaces, in which the wire was wound on silica tubes, were placed upon the market, and later muffle furnaces up to 5 ft. in length and 1 ft. in diameter were designed and put into service in laboratories and industrial works. Some of the many applications in which they have been successfully applied are the hardening and tempering of steel, annealing wire and heating rivets, melting aluminium, brass and other non-ferrous metals and, in some large factories in America, for hardening gear wheels and other machine parts. So far there is no metal-wound furnace which is satisfactory for use above 1,000 deg. C., or at the outside limit 1,100 deg. C., but there is in this type of plant a large field of service for a wire of some non-oxidising alloy capable of withstanding about 1,800 deg. C. The annealing of tungsten wire is at present performed in furnaces wound with molybdenum or tungsten and in which an atmosphere of hydrogen is maintained. Such a plant is not suitable for most of the industrial processes, where high temperatures are essential and the use of the refractory materials which are made into Nernst lamp filaments, which has been suggested, does not seem to offer greater promise. High temperature working is possible up to about 2,500 deg. C., in carbon resistance furnaces, but an atmosphere of a non-oxidising nature is necessary for their successful use.

The Element Hafnium.

Modern physical chemistry assumes that all the chemical elements can be arranged in a sequence, in which hydrogen bears the atomic number 1, and uranium, the heaviest atom, *i.e.*, the atom of greatest mass, bears the number 92. It appeared strange to the old school of chemists that there should be isotopes, *i.e.*, elements of the same atomic mass and number, yet differing in chemical properties; but radioactive research and positive-ray analysis seem to leave no doubt about the existence of these isotopes. On the other hand, neither of these lines of research, nor X-ray studies, on which Moseley had based his theory of atomic numbers, had, till last year, filled up any of the five gaps which apparently existed in the sequence of the 72 atomic numbers. Last May, however, Dauvillier and Urbain, the latter the French member of the International Commission on Atomic Weights, informed the Paris Academy that they had discovered an element having the atomic number 72—one of the five numbers which were missing. The element seemed to belong to the rare earths and they proposed to call it celtium. The identification was merely by X-ray spectroscopy, and the two lines on which Dauvillier and Urbain relied were extremely faint. Taking up this problem at the University of Copenhagen, D. Coster and G. Hevesy came to the conclusion that an element of atomic number 72 could not belong to the rare earths on the general arguments of the periodic law and particularly on Bohr's views respecting atomic structure. Their own X-ray spectroscopy of certain Norwegian zirconium ores gave different lines and suggested a new element homologous to zirconium; but again the evidence was only spectroscopic. The publication of these experiments by Coster and Hevesy, in *Nature* of January 2, induced Professor Alexander Scott, F.R.S., to resume the examination of a highly-refractory residue which he had, in 1913, isolated from the well-known black sand, occurring in abundance on the shores of Taranaki Bay in New Zealand. This black sand is a magnetic iron ore, rich in titanium, relatively very pure, but very difficult to smelt. From samples of the sand Dr. Scott had obtained an apparently new oxide. War work, and recently the study of the preservation of the relics from Tut-hank-amen's tomb had prevented him from pursuing his investigation. Last week he announced in the Chemical Society, of which he had been president during two of the war years, that he had within the last fortnight been able to determine the atomic weight of the element in this oxide, and had found it to be 180. That would agree with the atomic number 72, and the chemical behaviour of the new element suggested resemblance to titanium and a position in the periodic table between zirconium and titanium. He was able to show several grammes of the oxide which has a cinnamon colour. Dr. Scott rather regretted the name Hafnium which Coster and Hevesy propose for the new element (after Hafniæ, the latin name of Copenhagen); but he has offered his specimen to these investigators at the Danish University.

The Railway Wagon Question.

In discussing the wagon question in connection with the railways of this country, in a paper read before the Institute of Transport on Monday last, Mr. H. N. Gresley, of the London and North-Eastern system advanced the opinion that while a bogie wagon was probably out of the question for our general merchandise we might have something considerably larger than the present 10-ton to 12-ton vehicles. If constructed to the lengths adopted on the Continent our four-wheeled stock could be made of an increased capacity of 100 per cent. in the case of open wagons, and of 50 per cent. in the case of covered wagons. This would involve wagons 22 ft. and 24 ft. long respectively. Mr. Gresley proceeded to show that, if these were provided as replacement became necessary, a saving would be effected which, capitalised, would represent a sum far larger than what would appear to be necessary to alter loading docks, &c., to take such wagons. With regard to mineral traffic, Mr. Gresley followed up Sir J. F. Aspinall's argument developed in his James Forrest lecture last year. He proceeded further to argue that the railway companies were the chief beneficiaries under any scheme for the utilisation of larger wagons for coal traffic, and that it would be to the companies' advantage to give preferential rates for the shipment of coal in larger wagons than 20 tons. A group of collieries would then be able to give better terms than others retaining the small wagons, and would secure increased business. Similarly the small dealers of the London area would combine and secure cheaper rates, consequently being able to lower their selling prices. In addition to operating costs being decreased, by the more economically sized unit, a considerable saving would be effected by reduced train resistance. In confirmation of this Mr. Gresley gave an account of dynamometer trials he had conducted on the Great Northern Railway last year. In these trains, in order to secure uniform conditions and com parable results, the novel expedient was adopted of running two trains in one, separated by a dynamometer car. These two trains, or two sections of the one train, were composed respectively of four-wheeled and bogie stock. Immediately behind the locomotive was placed a dynamometer car followed by a rake of wagons. Next came the second dynamometer car followed by a second set of wagons. Wagons of each type were made up into separate sets, one rake comprising thirty 10-ton wagons and the other six 50-ton wagons. The order of these and of the dynamometer cars was varied so as to eliminate as far as practicable any possibility of the results being influenced by the "make-up" of the train. The weather was exceptionally good, and the figures for resistance were very low. They ran from 4¼ lb. per ton at 10 m.p.h. and 20 m.p.h. for the 10-ton wagon, up to 12½ lb. at 50 m.p.h. For the bogie stock the figure was 3½ lb. per ton at the two lower speeds, rising to 6¾ lb. at the higher speed. Based on these results Mr. Gresley concluded a decrease in resistance of 43 per cent. was shown for the bogie stock for a gross load of 1,000 tons, which incidentally meant an increase in paying load of 19 per cent., or 125 tons as compared with a 1,000-ton (gross) train of four-wheeled stock.

THE LATE MR. ALEXANDER ROSS.

It is with very great regret that we record the sudden death at Hampstead on Saturday last of Mr. Alexander Ross, past president of the Institution of Civil Engineers.

Born in 1845, Mr. Ross was in his seventy-eighth year at his decease. He received his early education at Aberdeen from whence he proceeded to Owens College, Manchester, which has since become the Victoria University. Practically the whole of his professional experience was gained in railway work. After leaving Owens College he was articled for five years to Mr. A. Fraser, engineer to the Great North of Scotland Railway, and on the completion of his pupilage in 1866 he acted as principal engineering assistant on the same line. From this position he passed in 1871 to the London and North Western Railway, where he became assistant to Mr. S. D. Worthington, M.Inst.C.E. In 1873 Messrs. John Gibb and Son, the contractors for the Leybourne and Hawes branch of the North Eastern Railway, appointed him engineer-in-charge of the construction, but in 1874 he returned to the service of the London and North Western Railway, and was, shortly after his return, made District Engineer, at Liverpool.

As such he was responsible not only for the maintenance and renewals of existing work, but also for station enlargements and widenings of the line.

After 10 years' further service on the engineering staff of this company Mr. Ross was, in 1884, appointed assistant engineer to the Lancashire and Yorkshire Railway, and six years later he became chief engineer to the Manchester, Sheffield and Lincolnshire line. Finally, in 1897 he succeeded Mr. Richard Johnson as chief engineer to the Great Northern Railway, from which post he retired in 1911 to practice as a consultant at Westminster.

Amongst the important works for which Mr. Ross was responsible may be mentioned the Leen Valley extension railway, the connecting line through Nottingham, and the Stevenage loop to King's Cross via Enfield, which gives the Great Northern an additional road into London alternative to the original main line, which, in certain sections south of Stevenage where there are numerous tunnels, has but two tracks. Mr. Ross was also responsible for part of the Piccadilly tube, which gives direct communication between Finsbury Park and the West End of London.

Mr. Ross became a member of the Institution of Civil Engineers in 1880. He contributed no papers to the proceedings, but at the engineering conferences of 1899, 1903 and 1921 he was called upon to inaugurate discussions on some important railway problems. On these he presented papers which, though short as the circumstances demanded, were very lucidly written. In 1899 the subject taken was "The Advantage or Disadvantage of Uniting the Lock and Block Appliances of Railways." Mr. Ross treated the question in the spirit of an inquirer rather than that of an advocate, being anxious to bring out the opinion of other railway engineers, in preference dogmatically to asserting his own views.

This note, included a description of the methods of block signalling so clearly expressed as to be easily intelligible to the layman. At the date in question ordinary block signalling had, on the purely mechanical side, attained nearly to perfection. So long as the signalmen followed their instructions a collision was impossible, but the fact remained that a failure of memory, or neglect, on the part of any one signalman might have disastrous results. It was the recognition of the inherent fallibility of the human element that led to the movement for uniting the lock and block systems, in which the telegraphic instruments in each cabin are interlocked with the outdoor signals, and the latter can only be lowered with the direct aid and assistance of the man in the box ahead. The additional safety of the system was obvious, but at the date of the discussion, engineers were much divided in opinion as to the extent to which it could be applied without giving rise to great delays at yards, stations and junctions.

At the conference of 1903 Mr. Ross dealt with the question of the "Assimilation of Railway Practice in respect of Loads on Bridges up to 200 ft. span." Whilst recognising that standardisation was capable of being so overdone as to check progress, Mr. Ross pointed out that, owing to the interchange of traffic between different railways, almost any bridge on one line might be called on to carry the heaviest load met with on another line. There were thus, he maintained, strong reasons for adopting standard systems of loading. To facilitate the preparation of such, Mr. Ross gave tables showing the "equivalent" uniform loads corresponding to the heaviest engines then in operation on our lines. Owing to loading gauge difficulties he did not anticipate any very great further increase in locomotive loads, and suggested accordingly that this table might form a convenient basis for the discussion of the proposed standards. An alternative suggestion made was the adoption of a conventional standard loading consisting of a continuous train of axles spaced at 5-ft. centres, each carrying a 16-ton or 18-ton load. He also drew attention to the very heavy loads which overbridges had to carry in some districts, where at times each wheel of a boiler wagon may support a load of 12 tons, the total load being 48 tons on a 13-ft. wheel base. In 1903 heavy motor traffic had developed but little, a steam lorry being the only type included in Mr. Ross's table. This lorry was credited with a wheel load of 4¼ tons, whilst the heaviest tramcar then in service had a wheel load of but 3¼ tons, which, owing to the stiffness of the rail, is, of course, much less concentrated than would be a similar weight on a motor lorry wheel.

At the conference held in 1921 Mr. Ross read a note emphasising the limitations from which British railways suffer, owing to their restricted loading gauge. He suggested that on main lines the 6-ft. way should be widened to 7 ft., and that when new tracks were laid down beside older ones, the space between should not be less than 11 ft. 6 in. Mr. Ross also pointed out that if Continental trains are ever to be admitted to our tracks, it will be necessary to do away with the existing high platforms so as to prevent fouling. If Continental rolling-stock is to pass freely over our lines, no structure more than 2 ft. 6 in. high must be brought within 5 ft. of the edge of the nearest rail. The standard overhead clearance should, he suggested, be made 15 ft. 6 in. above rail level.

Mr. Ross was President of the Institution of Civil Engineers in 1915–16, and in consonance with the conditions ruling at the time his inaugural address, which we published at the time, was devoted to certain weaknesses of our insular position, and the necessity of making these good by a better development of our natural resources.

As a member of the Metropolitan Munitions Committee Mr. Ross was of great assistance in the design and construction of the Perivale filling factory. He was also of much service to the War Office in selecting suitable men for commissions in the R.E. He had had, moreover, long service with the Territorials, being a lieutenant-colonel of the Engineer and Railway Staff Corps, and he held both the Long Service and the Decoration medals. Two of his sons were killed in the war.

Mr. Ross, moreover, took a very active interest in the work of the British Engineering Standards Association, serving on the Main Committee from 1912, when he was appointed on the recommendation of the Institution of Civil Engineers. He had naturally special interest on the standardisation of rails, joining, in 1902, the sub-committee appointed to deal with this, and of this committee he became chairman in 1912, an office he still held at the time of his death. He was also a member of the committee on sand-lime bricks.

The funeral took place yesterday at West Hampstead Cemetery.

Photograph by Thomas Fall.

THE LATE MR. ALEXANDER ROSS.

POTASH PROSPECTING IN THE UNITED STATES.—The United States Bureau of Mines announces that 219 permits for prospecting for potash on Government lands in certain western states had been issued up to December 1. Four leases for potash production, all in California, had been granted. Of the potash prospecting permits, by far the largest number, 170, were in Utah; 21 were in Nevada; 14 in California; 8 in New Mexico; 3 in Arizona; and one each in Colorado, Montana and Nebraska. The potash prospecting permits issued applied to 512,480 acres and potash leases to 7,343 acres.

DEVELOPMENTS OF THE CELLULOSE INDUSTRY,

Though Mr. C. F. Cross, F.R.S., had adopted the title "Fact and Phantasy in Industrial Science" for the discourse which he delivered at the Royal Institution last Friday, his discourse was essentially a continuation of a lecture on cellulose and artificial silk, which he had given in the same place three years ago, and his phantasy was restricted to potentialities based upon sound research. People generally are undoubtedly far too apt to underrate the immense importance of cellulose. The main product of vegetable life, cellulose is in fact indispensable to man in many respects, and it is closely related to the chief animal foods. As an art product, cotton fabric can be traced back to remote ages; the cellulose textile industry is modern, but hardly secondary to any other at present.

There is little scope for improvement in the primary mechanical treatment of the cotton bales, Mr. Cross remarked; but there is much to be done in the further treatment of the cellulose and in the utilisation of cellulose products, and a wide field is left for imagination in design, dyeing, printing and diverse applications. In spite of the perfections of modern machinery hand-block printing, known in ancient ages in India and on the Nile, has been practised in England since 1826, with remarkable artistic success, as Mr. Cross was able to prove by specimens, by four generations of one family living in the Cheshire village of Langley. About 1844 John Mercer improved the strength and lustre of the cotton fibre by steeping it in strong caustic lye. That long-disregarded observation led, by 1883, to the discovery of artificial silk. Chardonnet dissolved, for the preparation of artificial silk, nitrocotton in ether and alcohol; later copper oxide ammonia (cuprammonium) was used as solvent, and by 1895, Mr. Cross, who is responsible for many of the further developments of this industry, introduced acetic acid for the preparation of his viscose, one of the cellulose derivatives. The acetate (or acetyl) silk approaches natural silk most closely and can indeed be spun out to a tenuity exceeding that of the silkworm threads. But the acetate silk, though not spoiled by water, has hardly any affinity for most ordinary dyes, especially for the acid dyes. That difficulty has quite recently been overcome by Green and Saunders, who find that certain basic amido compounds (ionamines) which are sparingly soluble in water, but are easily hydrolysed, are readily taken up by the artificial silk imparting to it colours which may strongly differ from those which ordinary cotton assumes. Thus it is possible, as Mr. Cross demonstrated, to dye mixed textiles of cotton and silk in different shades in the same bath or in mixtures of two baths.

As regards the general history of the cellulose industry and raw materials, little progress had, Mr. Cross said, been made since the days of our forefathers. Ramie fibre had proved very useful; nettle fibre had been retried, but the preparation of the yarn was difficult and expensive. The arghan fibre, obtained from some South American *verbenaceæ* now cultivated in Malay, seemed far superior to jute (a typical ligno-cellulose) and was promising as an insulating material, also for cables in sea water. On the other hand scientific research, encouraged by industry in this country and elsewhere, had during recent years, opened out new fields.

Found in the purest form in the cotton-seed hairs, cellulose is always mixed with other cellular material, and, though remarkably stable in many respects, Mr. Cross pointed out, it is yet sensitive to all forms of energy, light, heat, chemical and electrical, and is profoundly affected in constitution and structure even by mechanical treatment. That is one of the reasons why the constitution of cellulose —probably a carbohydrate of the formula $(C_6H_{10}O_5)_n$ —is still unsettled, and the identity of the different cellulose varieties remains uncertain. The natural cotton forms flat fibres, irregular in section and often twisted. In caustic soda the cells swell, and the cell walls may burst; by suitable treatment, Mr. Cross has increased the surface development of viscose by as much as 66 per cent., increasing thereby likewise the lustre and covering power of the material. The swelling is a hydration effect, which is reversible. Dr. W. Lawrence Balls, chief of the Research Department of the Fine Cotton Spinners' Association (Manchester) has recently been able to follow the development of the daily growth rings of the cotton cell by photography. The photographs which Mr. Cross displayed, bore a close resemblance to the annual rings in trees; the thickness of the cell rings, after 25 days of growth, was only 0·4 μ, and thus smaller than the wavelength of sodium light. The specific volume of cellulose varies with the temperature when cotton is placed in liquids. In water there is a decided increase in the specific volume, between 30 deg. and 40 deg. C. while in toluene the volume decreases; these variations imply energy and constitution changes which must affect the fibre under ordinary conditions, in which violence is not done to the material, whilst it is generally the case in laboratory reactions.

Dr. J. S. Lewis, who is investigating these phenomena, is also studying the fluorescence of cellulose; most organic compounds fluoresce in characteristic ways. Some electrolytic effects, observed by Mr. Cross years ago, are now being examined by Professor Donnan and Mr. Rowe; the latter gave a demonstration during the discourse. A sheet of smooth paper—filter paper is too rough for the experiment—was wetted with distilled water and placed on a brass plate, which was joined to the one terminal of a 10-volt battery. A silver coin was then put on the top of the paper and touched with the other pole for a minute. When the coin was the anode of the electrolytic couple, the upper surface of the paper, in contact with the head of the coin, remained apparently unaffected; some silver was, however, dissolved, probably forming a colourless compound with the cellulose. When the current was then reversed, the dissolved silver was precipitated again and deposited in the upper surface of the fibres, giving a black image of the head on the coin. In similar experiments made with a type-metal stamp of the letter R (replacing the coin), the R appeared in brown on the paper. Theoretically interesting, these experiments in which, it will be understood, no electryte and only a small electromotive force are needed, also suggest practical applications.

Referring next to the fact that the bacteria of soil completely break down the cellulose, Mr. Cross mentioned that in works at Epsom some 300 lb. of sulphate wood pulp were now converted within three days into alcohol, acetic acid and lactic acid, large volumes of gases, hydrogen, methane and carbon dioxide, being evolved at the same time. These fermentation processes were controllable so that any of the three products, alcohol, acetic acid or lactic acid (wanted in the dye industry) could chiefly be prepared. Many materials of very little value, like maize straw and Nile sudds, might be utilised in this way. Finally, Mr. Cross showed a new product, a brown-coloured liquid, looking like a thin tar, which he had prepared by chemical means from waste wood. Mr. Cross did not explain his process; he merely pointed out that immense quantities of wood were still being wasted, and that his new product represented a 20 per cent. solution of colloidal lignone, a wood cellulose, which settled into a gel. Such a liquid or colloidal form of cellulose, available in large bulk, would lend itself to many diverse applications.

THE AIR CONFERENCE.

The third of a series of conferences which are arranged by the Air Ministry and are now held annually, took place in the Guildhall, London, on Tuesday and Wednesday last, the object of the conference being to provide an opportunity for the examination and discussion by representative members of all sections of the community of the problems associated with the development of air transport. Following the precedent established at the previous conference, the members paid a visit to the London Terminal Aerodrome at Croydon on Monday, the 5th inst., in order to inspect the organisation of a modern air station. We briefly described the arrangements at Croydon on page 173 of our 113th volume when dealing with the second conference, and as no great innovations have been made there since that time it is unnecessary to refer further to them here.

The proceedings at the Guildhall were inaugurated on Tuesday morning by the Lord Mayor, who welcomed the members of the conference on behalf of the Corporation of the City of London. He added that he was glad to note the progress recorded since the previous conference, and remarked that the City of London was fully alive to the importance of both military and civil aerial transport to the prosperity and to the existence of the Empire. He also assured the Secretary of State for Air of the City's support of any measures necessary to that end.

The Lord Mayor then vacated the chair which was taken by Sir Samuel Hoare, the Secretary of State for Air. Sir Samuel, after thanking the Lord Mayor for opening the conference, and also for permitting the Guildhall to be used for the proceedings, delivered his opening address. In this he remarked that the two great obstacles to the progress of civil aviation, at present, were shortage of money and the world confusion brought about by the war. The world was still living in an atmosphere of war, and while that was the case military aviation must have the first call upon the nation's purse. He was determined, however, to develop a consistant civil aviation policy and proceeded to indicate briefly some of the lines upon which that policy might be founded. Research he regarded as of vital importance, particularly in a country where aircraft construction was not carried out on a large scale, and he was equally convinced of the necessity for keeping the British aircraft industry in being. With regard to the cross-Channel services, he wished to base his policy upon two foundations, the first of which was that the operating companies should have a sufficiently long period of contract to enable them to sink capital and develop their routes. In this connection he expressed the view that there should be as little interference on the part of the Government as was possible under a subsidy system. Subsidies, he added, could not be justified if they gave the companies no incentive to develop. The second point in his policy had reference to an Imperial air route which Sir Samuel said he was most anxious to see started either by aeroplane or airship. Something had already been done in this direction with the fortnightly aeroplane service now in operation between Cairo and Baghdad. This, however, was a military service and could not be judged by commercial standards, but it carried 28 per cent. of the mail to Baghdad and the journeys, which were made with remarkable regularity, took only two days, instead of the 22 days occupied by ordinary methods of travel. Finally, he remarked that the chief need with air questions was an instructed public opinion, and he suggested that the work of the conference would assist in forming such an opinion.

The Position of Air Transport To-day.

The first paper to be read on Tuesday morning was that by Major-General Sir W. Sefton Brancker, Director of Civil Aviation, Air Ministry. In this long paper, Sir Sefton Brancker gave a very interesting review of the developments of the last year, referring first to the work of the International Commission for Air Navigation. He pointed out that difficulties had arisen with regard to non-signatory States coming into this scheme of international regulation, owing to the wording of two Articles of the original convention. One of these was concerned with making agreements with non-signatories with regard to flying over the territory of signatory States, while the other had reference to representation upon the Commission. Both these points were in a fair way to solution. As regards British services, the subsidy scheme had been completely re-arranged and competition eliminated. Last year, 621,725 miles were flown by subsidised concerns; this year a minimum of 637,846 miles is demanded. Two unsubsidised companies had done good work in connection with newspaper and taxi work, and sky sign-writing. The reliability of British services had increased; no paying passenger had been killed, and only one slightly injured in a collision on the ground. In 1920, 80 per cent. of the London-Paris flights were completed in four hours, 89 per cent. in 1921, and 92 per cent. last

year, the number of flights having in that time increased by 200. In three months, with 1,414 flights across the Channel, there were only four engine failures. In 1921, machines did 12 such journeys a month; last year they did 25, while there are indications that it may be possible to get 2,000 hours per annum out of a machine before long. The number of flying hours of pilots is also increasing. Both these tendencies will help to reduce cost of working. In 1921, only 19·4 tons of mails, parcels, &c., were carried for the year; last year the amount averaged 19 tons per month. Pilots are medically examined regularly at short intervals. Wireless telephony was in general use with control from Croydon, and location by Croydon, Pulham and Dover working in conjunction. A tug is maintained at Dover to respond to any wireless S.O.S. aircraft signal from the Channel. The future would probably see an extension of the use of navigators in addition to pilots.

Reviewing progress outside Great Britain, Sir Sefton Brancker referred to French activities and to those of Germany, giving some details also of the mail service between New York and San Francisco, which last year covered 175 million miles and carried 49 million pieces of mail. As regards the Dominions, the activities in Australia were specially noticed. Transport by airship had made little progress, though the United States were taking the matter up. A large number of the criticisms made at the last conference had been met by the Government, which was now considering a far-reaching policy. The co-operation which had been introduced between military and civil aviation was exemplified by the scheme for capitation grants to civil aviation schools for training reserve pilots, and the proposal to give an annual bonus for properly maintained engines of approved type. With a view to making civil aviation less costly in operation, Sir Sefton Brancker considered that much might be done in the production of a less fragile engine capable of 1,000 hours' running without overhaul, as compared with the 200 hours at present. We were also within reasonable reach of a reduction of fuel costs by the adoption of heavy oil in place of petrol. With greater reliability, insurance costs would be reduced also. Experiments in the direction of variable pitch propellers and two-geared engines would also probably lead to results of distinct benefit.

A Self-Supporting Airship Service.

The second paper taken at the morning session was one by Commander C. Dennis Burney, M.P., entitled "The Establishment of a Self-Supporting Airship Service." In it the author dealt mainly with the financial and political aspects of the problem, remarking that these were of more importance than any technical difficulties that might exist. The benefits that would accrue from the successful establishment of an airship service included the Imperial and political advantages to be derived from a safe and cheap form of transport that would provide for the British Empire the equivalent of the through trunk railways of America, as far as mails and passengers were concerned; the value in war time of a fleet of airships with fuelling bases all over the world; and the value of a commercial company with British capital operating a service on a profit-making basis.

After dealing with the outstanding defects which had hitherto prevented the development of airships for passenger transport, the author pointed out how these could now be eliminated, and gave particulars of some new vessels of 5,000,000 cub. ft. capacity which it is proposed to build. These vessels would be about 760 ft. in length and of a maximum diameter of 110 ft. Assuming a flight of 3,000 miles without re-fuelling, they would be capable of carrying 44·5 tons of mails, passengers, &c., at a speed of 80 miles per hour; or, allowing a total weight of 375 lb. for each passenger, would be capable of carrying 207 passengers and 10 tons of mails or other freight. The paper gave a detailed estimate of the capital cost, operating expenses and probable receipts of a fleet of six of such airships operating a bi-weekly service between this country and India. The estimated capital expenditure would be 1,830,000*l.* and the operating expenses and standing charges, 880,750*l.* per annum, while the receipts are given as 1,196,000*l.* from passengers, 515,000*l.* from mails, and 116,480*l.* from parcels and baggage, making a total of 1,827,480*l.* per annum. On the assumptions made, there would therefore be a very substantial margin of profit, and some profit would still be available if the receipts were only half the estimated figure. The author referred to a scheme submitted to the Admiralty in August last, and now under consideration, in which it was proposed that a commercial company should be formed to take over the Government airships and bases, construct a fleet of the latest type of vessels, build fuelling depôts and mooring bases at Port Said, Bombay, Rangoon, Singapore and Perth, and establish a bi-weekly mail and passenger service to India with a weekly extension to Australia. A capital of 4,000,000*l.* would be required for this purpose. The whole of the organisation would be at the disposal of the Admiralty in time of war, and the Government were therefore asked to guarantee the debentures as to principal and interest, and the ordinary shares as to dividends only, for ten years at the rate of 6 per cent.

The remainder of the paper was occupied in making a case for the use of airships in naval warfare, this being the only grounds upon which the necessary Government backing could be sought. The author mentioned, in this connection, that an airship detailed for reconnaissance duties only, could carry sufficient fuel to give a range of action of 20,000 miles, and as a rough estimate of the comparative cost of an airship and a light cruiser in searching a sea area of 1,000 sq. miles, gave the cost for the airship as 1*l.* 5*s.* and for the light cruiser as 77*l.* The same work could be done by nine airships as would necessitate the use of a fleet of 60 cruisers and the saving in capital cost by employing the former would amount to over 50,000,000*l.* To obtain the greatest air striking power, the author strongly advocated the use of large airships carrying aeroplanes, the latter carrying torpedoes, bombs or poison gas. He pointed out that 16 airships could be constructed at the same cost as one battleship, and these airships, between them, could carry 32 torpedo-carrying aeroplanes and 48 fighting aeroplanes. It was more than probable that a battleship would succumb to the attack of such a force of aircraft. In conclusion, the author pointed out that in the early days of the Navy there had been little difference between fighting and trading vessels, specialised fighting ships being introduced later. He therefore thought that airships should first be developed on a commercial basis and afterwards, when a divergence of type between naval and trading vessels was desirable, a state service, or Navy, of fighting ships should be inaugurated.

At the conclusion of Commander Burney's paper, the conference was adjourned until the afternoon, when three papers on technical subjects were read. We must defer reference to these papers, and the subsequent discussion of them, until our next issue, dealing now only with the discussion on General Brancker's and Commander Burney's papers.

Discussion on Civil Aviation.

On the Duke of Sutherland taking the chair on Wednesday morning, the discussion was taken on the two papers on Civil Aviation read the previous morning, and summarised above. His Grace, in opening the proceedings, thought that the question of extending the conference in future years to three or four days might be considered, in order that there might be more opportunity for valuable discussion by specialists of particular points. The conferences were of importance to the whole aviation industry. Those present could rest assured that the lines of the future policy to be adopted would be made known as soon as they were fixed. Substantial results had been secured by these meetings.

The first speaker was Mr. G. Holt Thomas, who said the Government would have the country behind it in any effort it made to advance aviation. He was not against Commander Burney's scheme, but they had not at present the data on which to argue that development should be brought about through commercial aviation. He was in favour of any scheme which would bring along the airship, so long as the money was not found by taking it away from aeroplane development. The conferences should deal more with the future; they were tending to become merely records of progress. They should encourage the presence of business men and pass resolutions which would carry weight with the Government. The United States had taken the practical course of instituting services, and it was certain they would be improved and developed. We should develop connections with outlying parts of the Empire. Compared with cabling, the transport of information, &c., by air was cheap. The Cairo-Baghdad route was really only a section of a much more important through route. The City had shown that it was able to put up money, and it would, if an Imperial policy were evolved. He would like to see the three cross-Channel companies come together. He concluded by proposing that a resolution be passed calling upon the Government to take effective steps to establish a mail service throughout the Empire.

This resolution was seconded by Admiral Mark Kerr, who said that when he had been considering the question of services in America, he had come to the conclusion that they should be developed from the freight point of view till they paid. There was an enormous quantity of small freight and money to be transported. If the Government would run through routes with mail services, they would pay after a while, and that fact would encourage freight which could undoubtedly be made to pay on services to Europe. The resolution was put to the meeting by the Chairman, and carried.

Lord Gorrell said that Commander Burney's paper put forward for the first time valuable figures regarding the superiority of airship over sea craft. He deplored the apparent desire in the paper to re-open the old controversy between the Air Ministry and the Admiralty. A State-guaranteed service could not be termed self-supporting. The trouble was that experiments with airship transport on a small scale could not be made, and if money were difficult to secure, he would prefer to see the little available spent on heavier-than-air machines. The three companies at present operating aeroplanes to Berlin, Cologne and Paris were working routes which were not temporary, but actually main arteries, and the first stages on longer routes. To popularise flying more care must be taken to reduce noise, or little expansion of traffic would occur. He believed development should be brought about with freight services. The United States' action was illuminating. Why was it impossible for our Post Office to take a similar view and carry letters without surcharge, or asking the sender how he wanted his letter carried? The attitude of mind of the Ministry was more important at the moment than actual decisions. He would like to see aviation taken out of the realms of party politics, with the Foreign Office and education. Nothing would be possible without a stable air policy.

Mr. F. Handley Page remarked, apropos of maps exhibited, showing air routes in Europe and Australia, that he hoped next year they would have a map giving routes covering the gap between. With regard to safety, &c., his company had had no claims against the insurance company in the last two years. Passenger traffic often did pay. The Wagon-Lits Company existed on it. Passengers would pay because their time was valuable. They needed longer terms than the present schemes, to make permanent developments. Any new scheme should be one in which research would be encouraged. The difficulty now was in even-ning-up the traffic in summer and winter, and resulted from the trouble of getting machines through in winter. Grants should be given with a view to making winter-flying more possible and regular.

Major-General J. E. Seely considered no material advance would be made unless the integral independence of the Air Ministry were assured. It would be well worth while if we could expand in the air. It was not wise to starve the air service. The elimination of noise was important to the passengers, but not less to the pilot, since he understood that the brain worked best in silence, and the noise influenced adversely the ability of the pilot to attend to many duties simultaneously. More attention should be turned to rising from and alighting on water.

Mr. Ashbolt, Agent-General for Tasmania, thought instead of an airship service being argued on the question of home defence, it should be advanced on an Imperial basis. The gradual frittering away of airship assets here was most regrettable, and he hoped nothing further would be done to decrease them until something had been decided on Commander Burney's scheme. Other systems of transport had been built up from small starts. With an airship service that could not be done. The big saving promised by the scheme in naval costs would more than compensate for the development of the Imperial routes.

Sir Alan Anderson said, in so bad a year as 1922, it was not surprising that a new industry like aviation had suffered. History proved that the nation that took the lead in commerce took it also in war, as only such a country could support successful military operations. For that reason the Ministry should not devote itself too much now to military aviation, but try to develop commercial service. An enormous amount had been spent on airships, but nothing had been done with them. Was their sole end to decay away? Personally, he had been greatly impressed with the possibilities of airships and the immense advantages to be obtained from reducing the distances between parts of the Empire.

Captain A. Instone said it was a misfortune that the scheme now operating should be considered as temporary only. Temporary conditions affected the manufacturing as well as operating companies. They wanted to see the prosperity of the industry as a whole. They had not yet got the commercial aeroplane and manufacturers could not spend money on development till they got more orders, which were impossible under temporary conditions. As regards international relations, he thought something should be done to see that British machines abroad received similar facilities to those accorded to foreign machines at Croydon. He did not think the small machine suitable for development of services in which they hoped to set down and pick up passengers. The Post Office might do more in the way of propaganda.

Admiral Mark Kerr said commercial aviation would benefit trade, but it was the one great backing to the military power of this country. It was obvious that London could be struck by an enemy before the Army or Navy could intervene. The money applied to the protection of the country should be spent in the right way. We had just decided to expend millions on two capital ships which would probably never come into action. Ten millions sterling would have put us safe in the air. The only answer to the submarine was air service, which would be the fighting service of the future, because it secured increased range. The cheapest way to develop was through commercial service, and our military greatness was based on commercial success. With regard to safety, he thought aeroplanes should be fitted with parachutes.

Mr. T. Fazackerley thought more might be done to stimulate interest in the provinces. Commercial and financial firms were not likely to put money into new ventures now. The public needed educating on the subject of the time saved. Greater facilities were needed for the collection and delivery of letters. The Government should advertise the services. Mail ships were subsidised and provided a valuable national reserve. Aviation might be regarded in a similar light.

Brig.-General F. H. Williamson said the Post Office was in constant touch with Chambers of Commerce. Last year they distributed 200,000 copies of a summary of the air services working. On the whole, 1922 had been disappointing. The parcels service to Paris had, however, shown an increase, and the use made of the Cairo-Baghdad service had expanded enormously. The total receipts on the latter only amounted to about 200*l.* per trip, so that that was not a commercial proposition. The distances in the United States were sufficiently great for the superiority of the air mail to be substantial. He thought night flying was essential, and if developed, a good many routes in Europe would be possible.

Sir H. White Smith said they had not got the commercial aeroplane, and that was essential to bring about the economy, safety and reliability necessary to encourage traffic. Research in that direction should be encouraged. He would like to see a Committee set up to go thoroughly into the question. He was very glad to hear that the Secretary of State had put research in a prominent place in his remarks on the previous day.

In reply to the discussion, Commander Burney said he had had no intention of raising the controversy with regard to the Air Ministry and Admiralty. His point was that money was necessary for the scheme. The Air Ministry had none; the Admiralty was a large spending Department, and the scheme suggested economies to it, and he therefore laid it before the Admiralty, whose duty it was to protect the ocean traders.

Sir Sefton Brancker, in reply, said it was very important to develop a reliable engine. The seaplane could not compete with the aeroplane up to a certain point, but for big machines and long distances, he thought it had a great future. For successful service they had to have volume of traffic. That did not seem possible between London and Paris, as the saving in time was not very great. Passengers certainly would pay for speed. The Government would formulate its final scheme as early as possible, as they realised the disadvantage of temporary arrangements. The present scheme, however, had been introduced chiefly because the original grant was becoming exhausted. Research was very important. They had recently called for tenders for three air transport machines. One was intended to be suitable for European work, such as the cross-Channel services. A second was designed to suit the conditions of the Indian route; the third was intended for a service such as London to Malta. The manufacturers were being given a very free hand on matters of ventilation and so on. The value of the parachute was mainly of a military nature. With enclosed cabins the subject was complicated, but there were few civil aviation accidents in which it would be of assistance. The risk of fire in British machines was a thing of the past. He agreed that if they thrashed out the question of aviation from the commercial point of view, the military value would be assured.

In adjourning the meeting, His Grace the Duke of Sutherland said he was all in favour of schemes covering longer periods.

(To be continued.)

THE LATE MR. MARK H. ROBINSON.

A figure familiar to a very wide circle of engineers has passed away during the week with the regretted death of Mr. Mark Robinson. At the time of his death, which occurred on the 2nd inst., Mr. Robinson was 79 years of age, having been born in 1844, the son of Commander E. Robinson, R.N. He received his education at the Royal Naval School, New Cross, and at the age of 17 entered the administrative branch of the Admiralty. He remained at the Admiralty for thirteen years, when he became manager of the Watney Brewery, Pimlico. This appointment he relinquished in 1881 when he joined the late Mr. P. W. Willans as partner in the firm of Willans and Robinson.

This firm, as is well known, had works originally at Thames Ditton. They were launch and yacht builders and makers of marine engines, later on taking up the development of high-speed vertical steam engines. After the death of Mr. Willans, Mr. Mark Robinson became chief manager and director of the firm, and with Captain H. R. Sankey was responsible for all the machinery produced by the firm. Subsequently, of course, the firm removed to Rugby, and became one of the most important in the country. Of this he was chairman until 1909.

Mr. Robinson had a good many inventions to his credit. For some time he had a private workshop in which was made a boat disengaging gear patented by him and for long used exclusively in the Royal Navy. In conjunction with Mr. Willans he patented many improvements connected with single-acting high-speed steam engines, the chief of which perhaps was the system of cushioning by compressed air.

He became a member of the Institution of Civil Engineers in 1893, but was probably better known to members of the Institution of Mechanical Engineers, of which he became a member in 1894. He took a very active interest in the affairs of this Institution and was elected a Member of Council in 1901, a position he retained until he was appointed vice-president in 1913. He continued to fill this office until 1920, but latterly had the misfortune to be greatly handicapped by severe deafness, which made it difficult for him to take a leading part at meetings, &c. When the new rules came into operation he was appointed a past vice-president, which position he only resigned at the close of last year. He did a lot of most useful work for the Institution, being keenly interested in seeing it placed upon a sound financial footing. For many years he was chairman of the Finance Committee, and was mainly responsible for the details of the scheme for sinking fund, &c. This scheme included the setting aside of 20,000*l.* in 5 per cent. war stock, which, with accrued interest, would have furnished an amount sufficient to provide the Institution with its own building and freehold. The whole aspect of this excellent scheme was unfortunately changed by the war as the Institution was informed by Dr. Hele-Shaw, in his presidential address delivered in October last. Mr. Robinson became a member of the Institution of Naval Architects in 1887. He became a member of the Institution of Electrical Engineers in 1888, and served on the council of that body from 1901 till 1903. In 1895 he was awarded an Institution premium for a paper on "Recent Developments of the Single-Acting High-Speed Engine for Central Station Work," and in 1897 he received the award of a Willans' premium for the same contribution. He was a Justice of the Peace for Warwickshire.

It may be mentioned that prior to the war he was connected with a scheme to develop Sandwich Haven. This was interfered with by the war, but it will be remembered how subsequently the idea was developed by the authorities so that under the name of Richborough this became one of our most valuable military links with the Continent. Richborough is situated somewhat higher up the River Stour than the point at which Mr. Robinson proposed to build a harbour. He foresaw the possible difficulties in connection with silt, and one of the principal points of his scheme was the construction of a dredged channel between training walls to form a permanent narrow channel which the flow of the river was expected largely to keep clear.

For many years during the earlier part of his professional career, Mr. Robinson was a frequent contributor to the pages of Engineering, his articles relating chiefly to naval matters.

THE LATE MR. ARTHUR MECHAN.

A connecting link between the present day Clyde engineers and shipbuilders and some of the great pioneers who established the firms on the river, whose names have become known the world over, has been broken by the death of Mr. Arthur Mechan, which took place on Wednesday, January 31, at his home, Clifford Lodge, Largs. He was born in Glasgow ninety years ago and when he was thirty, after receiving a thorough training in mechanical engineering, he started a small engineering business in his native city, which under his management and that of his sons developed into Mechans, Limited, of Scotstoun Ironworks, Glasgow. At the jubilee of the firm, in 1912, he was shown the deep regard of his employees and associates in the business by many presentations. On that occasion there were more than 100 employees present who had been in the service of the firm for more than twenty-one years. Although he handed over the active management of the business to two of his sons, Mr. Henry Mechan and Mr. Sam Mechan, about thirty years ago, he still kept in close touch with the business and maintained his desire for the welfare of his employees. His interest in public affairs prompted his entry into the municipal politics of both Glasgow and Largs, of whose Town Council he was for many years an active member.

Mr. Mechan had a great store of personal reminiscences of the older school of Clyde engineers and possessed the rare faculty of imparting his knowledge of those personalities in true perspective.

The Junior Institution of Engineers.—The council has received representations from several members that the annual excursions which were a special feature of the Institution's summer activities before the war should now be resumed. The council is in agreement with this suggestion provided it is assured that the attendance warrant the necessary preparations. It is proposed that the excursion shall extend over a period of six or seven days, commencing on or about Saturday, July 21, and that Sheffield be made the centre.

The British Cast-Iron Research Association.—The Research Committee have appointed as research assistants Mr. E. C. Dickinson, B.Met. (Lincoln), who will work at the Sheffield University, and Mr. H. J. Simcox, B.Sc. (West Bromwich), to work at the Birmingham University. Mr. Oliver Stubbs, M.I.Mech.E. (Manchester), has been appointed chairman of the Executive Committee of Council, and Mr. F. J. Cook (West Bromwich) has been appointed chairman of the Research Committee. During the past month several large firms have joined the association. The revival of trade is shown by the increasing use which members (particularly large firms) are making of the assistance of the association in the solution of some of the difficulties that arise in their foundries.

RECORDING SCLEROSCOPE AND PNEUMATIC RELEASE PEDAL.

CONSTRUCTED BY THE SHORE INSTRUMENT AND MANUFACTURING COMPANY, JAMAICA, N.Y., U.S.A.

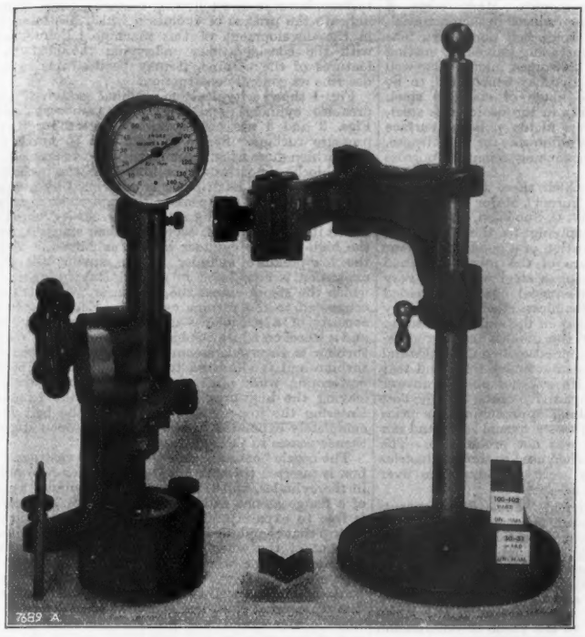
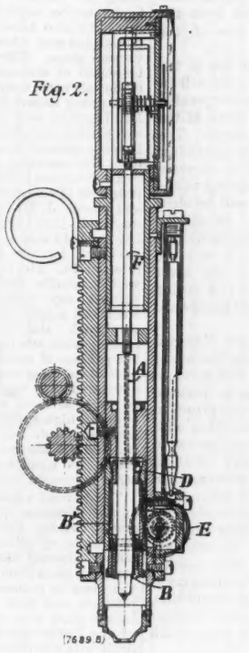
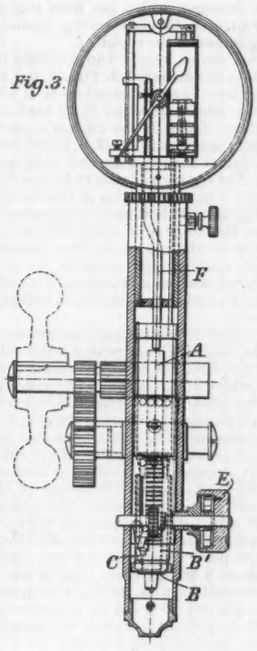


FIG. 1.





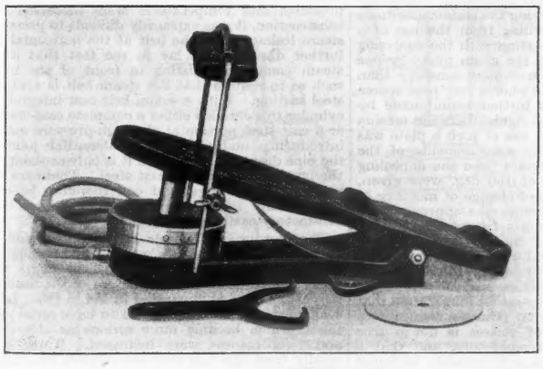
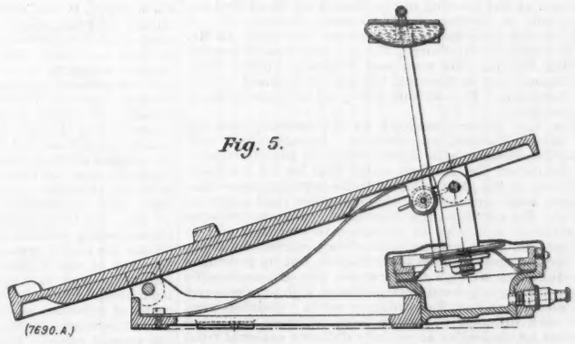


FIG. 4.



THE scleroscope has now been employed for many years as a rapid and convenient means of determining the hardness of metals, and has thoroughly demonstrated its suitability for workshop use. As usually constructed, the instrument comprises a hammer which is dropped from a fixed height on to the body to be tested, and the height to which the hammer rebounds is noted on a vertical scale. The proportion of the striking energy of the hammer which is absorbed by the penetrative resistance of the metal under test is a function of the hardness of the latter, a soft material absorbing more energy than a hard material, and *vice versa*. The height of the rebound of the hammer is therefore greater when a hard metal is being tested than is the case with a softer material, and from this it follows that the height of rebound is a measure of the hardness.

In Figs. 1, 2 and 3 annexed, we illustrate a new design of scleroscope brought out by the Shore Instrument and Manufacturing Company, Van Wyck-avenue, and Carll-street, Jamaica, N.Y., U.S.A., the special feature of this instrument being that the necessity for observing the momentary position of the hammer at the upper limit of its rebound is avoided, the reading being given by a hand which moves over a circular dial and remains fixed in its maximum position until released by the operator. The improved instrument with two different forms of stand, is shown in Fig. 1, while the design and construction of the essential parts are clearly shown in Figs. 2 and 3. The principle employed in the instrument illustrated is the same as that used in the earlier models and briefly explained above, but the hammer, lettered A in Figs. 2 and 3, is heavier and longer, and falls and rebounds through a shorter distance; the drop, it may be mentioned, is actually $\frac{3}{4}$ in. The hammer is surrounded by a sleeve B which serves to hold the hammer in its upper position, and when released by the movement of the hook C, shown in Fig. 3, the sleeve and hammer both fall together. At the end of its stroke, the sleeve B strikes a projecting shoulder on another sleeve B^1 which is connected at its upper end to a cage carrying a number of steel balls arranged in a conical space so as to form a sensitive ball clutch. The movement of the sleeve B^1 produced by the contact of the sleeve B, brings the balls of the clutch, which is lettered D in Fig. 2, into contact with the body of the hammer and it will be evident that with this arrangement, the hammer will be free to rebound upwards after it has struck the test-piece, but any downward movement of the hammer relatively to the sleeve B^1 will be prevented by the clutch.

It will thus be clear that the hammer will be fixed in a higher position relatively to the sleeve B^1 than it was at the commencement of the operation by an amount which is exactly equal to the height of the rebound. By means of a knob E and a rack and pinion gear, the sleeves and hammer together are then raised, bringing the sleeves to the original position, and the upper end of the hammer into contact with a rod F connected to the dial-gauge. Before starting a test, the lower end of the rod F just touches the upper end of the hammer so that since the hammer after a test has been raised by the rebound, the rod of the dial-gauge is moved upwards by an equal amount when the moving parts are raised by turning the knob. The reading of the gauge is thus exactly proportional to the height of rebound, and can be used as a measure of the hardness of the material tested. To reset the instrument for another test, the hammer must be restored to its original position in the sleeve. This is done by turning the knob so as to cause the hammer and clutch sleeve B^1 to descend together, the hammer afterwards coming into contact with the sleeve B, on which it remains at a fixed height from the test-piece. Further downward movement of the clutch sleeve, releases the ball clutch, moves the hook C and allows the hammer and sleeve B to drop for another test. The coarser rack and pinion shown on the left of Figs. 2 and 3 is used for raising and lowering the instrument bodily in its stand so as to clamp the object to be tested between the lower end of the tube and the base of the stand. The stand of the swinging-arm type shown on the right of Fig. 1 is used for testing light and slender objects which have to be held in a vice. Larger pieces can also be tested with this stand by placing them on a heavy plate on the bench. It is possible, though not desirable, if other means can be employed, to carry out tests with the dial-gauge and tube part of the

instrument held in the hand, the ring shown on the left of Fig. 2, being provided for this purpose. On the right of Fig. 1 are shown two of the standard test blocks used for checking the indications of the instrument from time to time, and in the centre of the figure is a "vee" block in which cylindrical objects are placed for testing. In the same illustration, on the extreme left, the hammer, which has been removed from the instrument, can be seen resting against one of the levelling screws of the stand.

Another device intended to facilitate the use of the scleroscope is illustrated in Figs. 4 and 5. As will be gathered from these illustrations it is a foot-operated pneumatic release intended to be used in place of the bulb release fitted to the ordinary scleroscope. The pneumatic pedal, as it is called, leaves both hands free to manipulate the specimen and is claimed to increase the speed of testing and also to be less fatiguing to the operator. The construction of the device will be clear from Fig. 5 with but little explanation. As will be seen, the foot-lever is provided with an adjustable pad which fits on the top of the foot, keeping it in place and also enabling the operator to move the lever upwards, as well as downwards, if desired; a spring is, of course, provided, as shown, to facilitate the upward movement.

The necessary suction and compression are obtained by a diaphragm of Para rubber which forms the upper end of a cylindrical box fixed under the foot-lever as shown in both Figs. 4 and 5. The diaphragm is operated by a rod pivoted at one end to the foot-lever and attached to the diaphragm at the other end, the connection with the diaphragm being made by metal discs, shown in Fig. 5, to prevent the chafing of the rubber. A small nozzle is screwed into the box so that connection can be made to the pneumatic release of the scleroscope by means of a rubber tube. The rubber diaphragms are the only parts subjected to heavy wear but the makers state that they are very durable. In any case they are plain discs and can be easily and quickly replaced at a trifling cost. One of the diaphragms is shown in the foreground of Fig. 4 on the right-hand side, and on the left of it can be seen the special spanner used to remove and replace the screwed ring which fixes the diaphragm in position.

SOCIETY OF GLASS TECHNOLOGY.

PROFESSOR W. E. S. TURNER, D.Sc., President, presided at the meeting of the Society of Glass Technology, held in Sheffield on Wednesday, January 17. A very cordial welcome to the meeting was given to Mr. H. L. Dixon, of Pittsburgh, U.S.A., who was at present visiting Europe. He was, said Professor Turner, well-known not only in America, but also in England and on the Continent. He had built nearly all the glass furnaces in America.

The first paper presented to the meeting was by Dr. W. H. Hatfield, and entitled "*Stainless Steel, with Some Consideration of its Application to the Glass Industry.*" At the outset, Dr. Hatfield stated that he did not know sufficient of the glass industry to do anything more than suggest some directions in which stainless steel might be useful. He remarked that the most important property of stainless steel was its resistance to corrosion and to oxidisation. The resistance to ordinary corrosion was not of much interest to glass technologists, but its resistance to oxidisation at high temperatures was of considerable interest, especially from the fact that at high temperatures it scaled much less than ordinary steels. Stainless steel had such different properties from ordinary steel that it must be studied as an entirely different material from many points of view. After demonstrating how nitric acid rapidly attacked ordinary steel but left stainless steel unaffected, Dr. Hatfield said that stainless steel could now be made direct into castings, while sheet steel, which was very malleable, could also be made. The making of sheet steel was a development of the last two years. Then, again, it could be drawn into tubes, so fine that hypodermic needles were now largely made from stainless tubes. Turbine blades had been successfully produced, and in this case the steel was brought into contact with steam at high temperatures. He showed pieces of turbine blades that had been in use eighteen months and still retained their special properties. These he compared to ordinary nickel steel which lost so much material that they had ceased to function properly. Very many of the turbine manufacturers had adopted stainless steel as being the most effective material for the manufacture of blades. Stainless steel was an alloy of iron and chromium. It contained from 12 per cent. to 14 per cent. of chromium. The carbon content varied a little with the different types of stainless steel, but for general purposes might be considered to be about 0·30 per cent., which was very similar to ordinary structural steels.

Dr. Hatfield showed by lantern slides the action of various corrosive and oxidising influences on stainless steel. They were able to make a stainless steel which would be impervious to sodium sulphate, though some types of stainless steel were liable to be affected by continued contact with it. He showed micrographs illustrating the structure of various special steels such as nichrome and tantiron. The former, he said, resisted oxidising influences and maintained its strength at high temperatures. Tantiron was not ductile, but relatively hard and brittle like cast-iron. With regard to the glass industry, he considered that stainless steels could be considered as alternatives for those now used, from two standpoints, which were the resistance to scaling and its strength at high temperatures. Stainless steel had a high tensile strength, equal to the best alloy steels, had a high fatigue range and might be hardened and tempered. There were many directions in which the material might be useful, the most notable, in his opinion, being for parison and blow moulds. Many parts of feeder devices might be usefully produced in such material, as might also blowing irons, rolls, belt conveyors, lehr chain pins and other things, including knives for cutting viscous glass. The ends of blowpipes might very well be made of stainless steel. Brushes which had to be made of wire could well be made of stainless steel. Explaining recent developments in the use of this steel, Dr. Hatfield said that where a highly polished surface was needed, stainless steel was admirable for the purpose. Indeed, several firms were producing scientific mirrors from this material.

A discussion followed in which there took part the president (Professor W. E. S. Turner), Major V. F. Gloag, and Messrs. J. H. Davidson, W. C. Snowden, R. Hemingway and Guy Simpson. Replying to the discussion, Dr. Hatfield said that the question of a good surface was answered by the manufacture of the mirrors he had referred to. He thought stainless steel would do very well in muffle lehrs. Stainless steel could be welded without any difficulty to stainless steel or ordinary steel, but a good deal depended on the skill of the smith employed. He thought that the moulds used in glass-making were too heavy. Stainless steel could withstand the process of crushing and also ordinary wear and tear as well as most materials. He was not able to answer questions with regard to comparative costs, but the cost of stainless steel was something approaching the price of cheap high-speed steel. It was a special steel, and not a cheap steel, but the cost was not prohibitive. The expense was always justified when used in those industries where its special properties were an advantage over other materials.

The second paper was entitled "*Some Measurements of the Viscosity of Glasses near their Annealing Points and a Critical Review of Some Recent Literature on the Annealing of Glass,*" by Mr. S. English, M.Sc. The author showed that contrary to the general opinion, strain in glass could not always be detected by examining the glass in polarised light, and that the most sensitive position was that in which the direction of the strain in the glass was at 45 deg. to the plane of polarisation of the light. In discussing strain viewers the lecturer dealt with the defects in design of a strain viewer recently put on the market and showed that with a strain viewer of this type it was very easy to obtain misleading indications of the presence of strain. Reviewing the statements made concerning the advantages accruing from the use of a selenite or quartz plate in connection with the analysing Nicol prism, it was shown that the claim made by one author that the selenite plate was more sensitive than plain crossed nicols was only true when a very poor source of light was used, and that a further claim made by another author to be able to distinguish between tension and compression stresses by the use of such a plate was entirely untrue. Details of the measurements of the mobility of various types of glasses from the annealing temperatures through a range of 150 deg. were given, and it was shown that the rate of change of mobility of the glasses at their annealing points was approximately constant, most of them requiring a rise of temperature of 9 deg. to cause a doubling of the mobility. In some cases this temperature interval rose to as much as 11 deg. At temperatures of 100 deg. or 150 deg. above the annealing points the temperature interval required to double the mobility was generally rather longer than that required at the annealing points. Curves were shown indicating that the mobility of glasses is not a true logarithmic function of the temperature, and that a point of inflection in the curves will probably be found at temperatures rather higher than those included in the present range. It was also suggested that the well-known working properties of lead glasses and other soft glasses are determined more by the rate of radiation of heat than by rate of change of viscosity with temperature.

During the forenoon, by the courtesy of the directors, members had the privilege of visiting the works of Messrs. Thomas Firth and Sons, Limited, Sheffield, where they saw various processes in the manufacture of stainless steel.

THE SWEDEN–FINLAND TELEPHONE.—The Finnish Ministry of Finance has sanctioned a grant for work in connection with the telephone between Finland and Sweden. Even if promptly granted by the Diet, it will be too late for ordering the cable early enough to lay it this summer. The laying can only take place in the summer months. It will most probably have to stand over till 1924.

PROPOSED NEW DOCKS AT THE PORT OF CALLAO.—The Acting British Consul at Callao, Peru, has forwarded to the Department of Overseas Trade an extract from a Lima Journal which gives some details of a proposed scheme for new docks at the port of Callao. The scheme was designed in 1920 by an American civil engineer, but attention is again focussed on the matter by the recent arrival in Lima of the president and general manager of a New Orleans firm of civil engineers and contractors, accompanied by a former Peruvian Consul-General in New Orleans. The extensions are estimated to give, besides the necessary improvements in auxiliary services, a total merchandise tonnage capacity for the port of over 1,000,000 tons per annum, or twice the tonnage dealt with in 1921.

METROPOLITAN-VICKERS RATEAU MARINE TURBINE.*

By H. L. GUY and P. L. JONES.

THE authors, having been invited to contribute a paper upon the Metropolitan-Vickers Rateau marine turbine, have, in the following remarks, endeavoured to indicate the process of evolution which has taken place in the development of this machine. Before dealing with the considerations underlying the characteristic features of the turbine, it may be desirable to briefly describe its general construction.

Fig. 1 shows a typical longitudinal section of a high-pressure cylinder, and Fig. 2 a transverse section. Figs. 3 and 4 are corresponding section for the low-pressure turbine. Steam is admitted to nozzle boxes R R, which more usually are constructed to accommodate three blocks of nozzles, the number of nozzles in the blocks being different. Each block is controlled by a separate cut-out valve. After passing through these nozzles the steam performs work on a two-row velocity wheel, after which it passes through several Rateau stages A, leaving the high-pressure cylinder by the exhaust C. Entering the low-pressure cylinder at the steam belt D, the expansion is completed in several Rateau stages, after which the steam enters the condenser, which is directly connected to the turbine cylinder. Each Rateau stage consists of a stationary diaphragm containing nozzles and a wheel on which the blades are mounted. When the turbine is reversed, steam is shut off from the ahead turbine and is admitted to the astern nozzle blocks S, performing work on the two-row velocity wheel, and leaving the high-pressure cylinder by the exhaust H. Entering the low-pressure turbine at the belt B, it is completely expanded in two or more Rateau stages and thence passes to the condenser.

The nozzle boxes are pipe-shaped steel castings. Each box is inserted through a suitable circular hole provided in the cylinder, and is secured to the cylinder by means of a flange at one end of the box only. The other end is free to expand and is provided with a guide pin to ensure that the plane of the nozzles is maintained parallel to that of the wheel and the nozzles themselves concentric with the wheel. Fig. 5 shows a set of these nozzle boxes. It will be seen that they are of very stiff construction and well suited for withstanding deflections due to internal pressure. In the earlier designs of turbines a steam belt was provided at the high-pressure end of the cylinder, this belt being cast in the cylinder itself. Suitable slots were cut through the walls of the belt and the nozzle box bolted up. This design is illustrated in Fig. 6 (A). It was found that, as steam pressures and temperatures were increased with this construction, it was extremely difficult to prevent serious steam leakage from the belt at the horizontal joint. A further disadvantage lay in the fact that usually the steam conditions existing in front of the nozzles are such as to require that the steam belt is contained in a steel casting. With a steam belt cast integral with the cylinder this entailed either a complete cast-steel cylinder or a cast-steel portion at the high-pressure end, thereby introducing undesirable circumferential joints. With the pipe design of nozzle box it is only necessary to make the boxes themselves of cast steel. These are small and very simple castings, and can therefore be easily and economically made, and at the same time thoroughly satisfactory castings can be relied upon.

The first type of nozzle box adopted, and which is still used by other makers, was inserted through a port of segmental or rectangular shape, whose length was necessarily greater than that of the arc of the nozzles fed by it. This design is illustrated in Fig. 6 (B). In practice, such nozzle boxes were found to have certain disadvantages, which became more serious as steam pressures and temperatures were increased. These arose principally from the fact that the relative expansion of the nozzle box and the cylinder to which it was attached is 0·001 in. for each inch length of opening for 150 deg. F. temperature difference between the nozzle box and the cylinder. If the fastening of the nozzle box to the cylinder was sufficiently rigid to wholly restrain this relative expansion, distortion of the cylinder or nozzle box usually resulted. If, on the other hand, the restraining forces were not sufficient to completely prevent the relative expansion, the joint between the nozzle box and the cylinder was ultimately sheared, and trouble arose from a leaky joint. It was difficult to make a good joint initially because of the elongated rectangular shape of the opening, and many methods which are successfully applied to making ordinary circular joints could not be used in this design. In the pipe type of nozzle box the diameter of the circular opening necessary to introduce the nozzle box is only a fraction of the length of the nozzle arc fed by it, and experience has proved that with the high steam pressures and temperatures now adopted these joints can be successfully made and maintained tight.

It has been suggested that, with the pipe type of nozzle box, difficulty may be experienced through the box tending to open out under the influence of steam pressure. In order to satisfy themselves on this point, Metropolitan-Vickers carried out tests on several boxes of this type, and the results obtained from one such test are shown in Fig. 7. In a normal design the pressure existing in the nozzle box is of the order of 200 lb./sq. in. gauge, and the pressure existing in the first stage of the turbine of the order of 50 lb./sq. in. gauge. Measurements were taken of the change of the chord length and also of the change in the width of the slot opening. It will be observed that with a pressure difference of from 150 lb./sq. in. to 200 lb./sq. in. these changes are very

* Paper read before the Society of Naval Architects of Japan, at Tokyo, October, 1922.

METROPOLITAN-VICKERS RATEAU MARINE TURBINE: HIGH-PRESSURE CYLINDER.

Fig. 1.

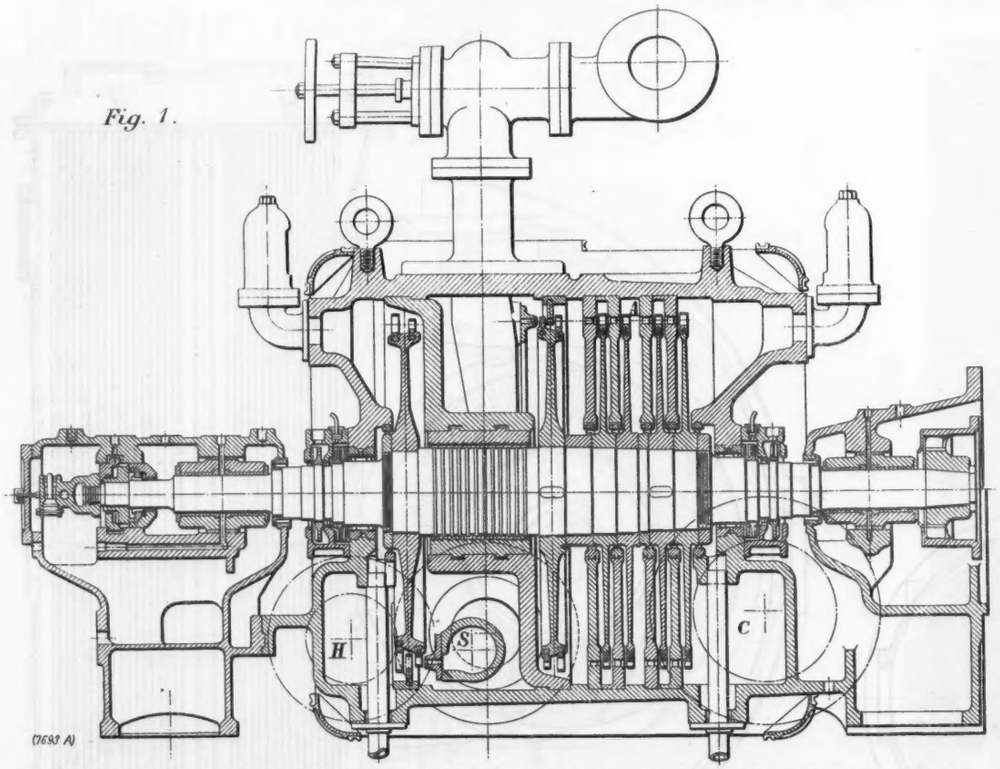
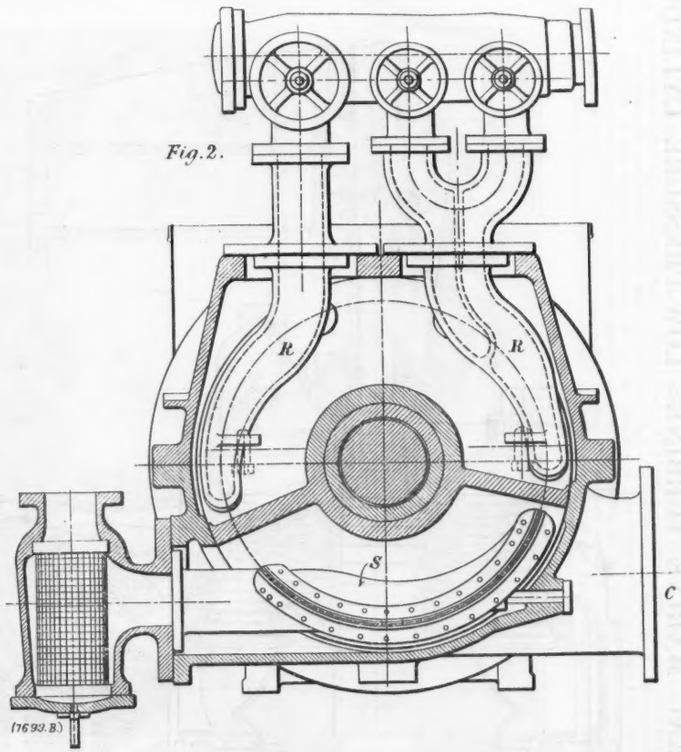


Fig. 2.



small. It is to be observed, further, that in these tests the slot openings were blanked off by means of a flexible copper joint, which is equivalent to an expansion joint. The box, therefore, received no support, such as would be received under normal operating conditions from the nozzle block, which is bolted to it. With the nozzle block bolted on, these deflections are materially reduced, particularly the slot opening.

One of the most characteristic features of the Rateau turbine is the method of fastening the blades to the wheel by riveting. Metropolitan-Vickers have experimented with and used a variety of blade fastenings and accumulated considerable experience with these types before the methods now adopted became their standard. In small turbines, and some of the earlier machines, blades were attached by caulking the packers into slightly dovetailed grooves. This method was satisfactory for very low speeds only, and was early abandoned because of the difficulty inherent to all caulked attachments of being able to ensure that the caulking was sufficiently complete to prevent the blades breaking loose under running conditions.

A number of tests were carried out by us on the efficacy of dovetail fastenings. These tests demonstrated that the jaw of the fastening was forced open perceptibly, concentrating the stress on the corners of the tongue, thus causing failure to take place at lower loads than would be expected from calculations based on the assumption that the load on the dovetail was uniformly distributed over its bearing surface. The critical speed of a blade depends not only on the rigidity of its attachment axially, but in any dovetail fastening, also on the extent to which a particular blade is backed up by the neighbouring blades or packers. While the backing up may be effective with the wheel stationary, its effect decreases as the speed increases, and may easily become zero at the normal running speed. This is a serious matter, because there is always sufficient disturbance in a turbine to induce vibration in any member which is not rigidly fastened, and such vibration may ultimately cause a fracture. The critical speed of a blade with this type of fastening, therefore, varies with the speed, and, in consequence, it becomes a very difficult problem to determine the critical speeds of the blades with sufficient accuracy to ensure that there is no danger of synchronous vibration being stimulated at any of the running speeds. Metropolitan-Vickers, therefore, have adopted "T" root fastenings for short blades only, where the loading is comparatively very light, and the critical speed high under all conditions of running.

At one time welding appeared to offer an attractive means of attaching blades. Metropolitan-Vickers, therefore, investigated the possibilities in this direction, and their experience was that, while a very large percentage of welded blades when tested did not fracture at the weld, it was apparently impossible to ensure a good weld in every case, a certain percentage always failing at the weld, with a load only a fraction of that sustained by the good weld. An analysis of the tests showed that approximately 95 per cent. of the welds were good, but 5 per cent. broke down with about half the load sustained by the others. In view of this fact, and having regard to the very large number of welds which would be necessary if all the blades on a rotor were attached in this way, welding was abandoned. The riveted fastening used to-day by Metropolitan-Vickers is identical with that used in the earliest turbines of this type built by them 14 years ago. As the necessary duty has changed in the development of the art, the riveted fastening has been found to meet all requirements. It is always possible to design a riveted root so that it is stronger than the active portions of the blade. In this case the backing up which is such an important factor in stiffening the blade is provided by the rivets themselves. As the length of blades and their peripheral speed is increased, the number of forks on the blade have been increased so that the number of shears on the rivet are increased as illustrated later in this paper. In this way blade fastenings have been manufactured for blades 17 in. long, rotating with a tip speed of 840 ft./second on a mean diameter of 63 in.

In considering blade fastenings, the importance of the rigidity of the fastening on the critical speed of the blade has already been referred to, and the conclusions stated are the results of experiments and experience. It has long been the standard rule amongst makers using methods of fastening other than riveting, that the calculated critical speed of the blade must be at least 3·5 times the running speed if failures of blades due to vibration troubles are to be avoided. In order to ascertain the critical speed of blades, the apparatus shown in Fig. 8 has been employed by the Metropolitan-Vickers research department. In this the blade A under test is attached to its holder C in exactly the same way as the blades are attached to the wheel in a finished turbine. By operating a switch, magnet B plucks the blade and starts it vibrating. At the same time the magnet F releases the smoked plate E, which falls against a stylus attached to the end of blade A. In this way a graph is scribed on the plate, as shown in Fig. 9, from which the frequency of vibration can be calculated in the usual way. The results of tests taken in this way on two typical blades are as follows:—

Blade.	Calculated C.S.	Test C.S. with riveted root.	Difference in per cent.	Test C.S. blade in vice.
1	5,200	4,578	13·7	5,454
2	3,070	2,820	9·0	3,228

The calculated critical speed was obtained by treating the active portion of the blade as a cantilever and adopting the usual graphical construction. Such results illustrate the importance of the rigidity of the blade

METROPOLITAN-VICKERS RATEAU MARINE TURBINE: LOW-PRESSURE CYLINDER.

Fig. 3.

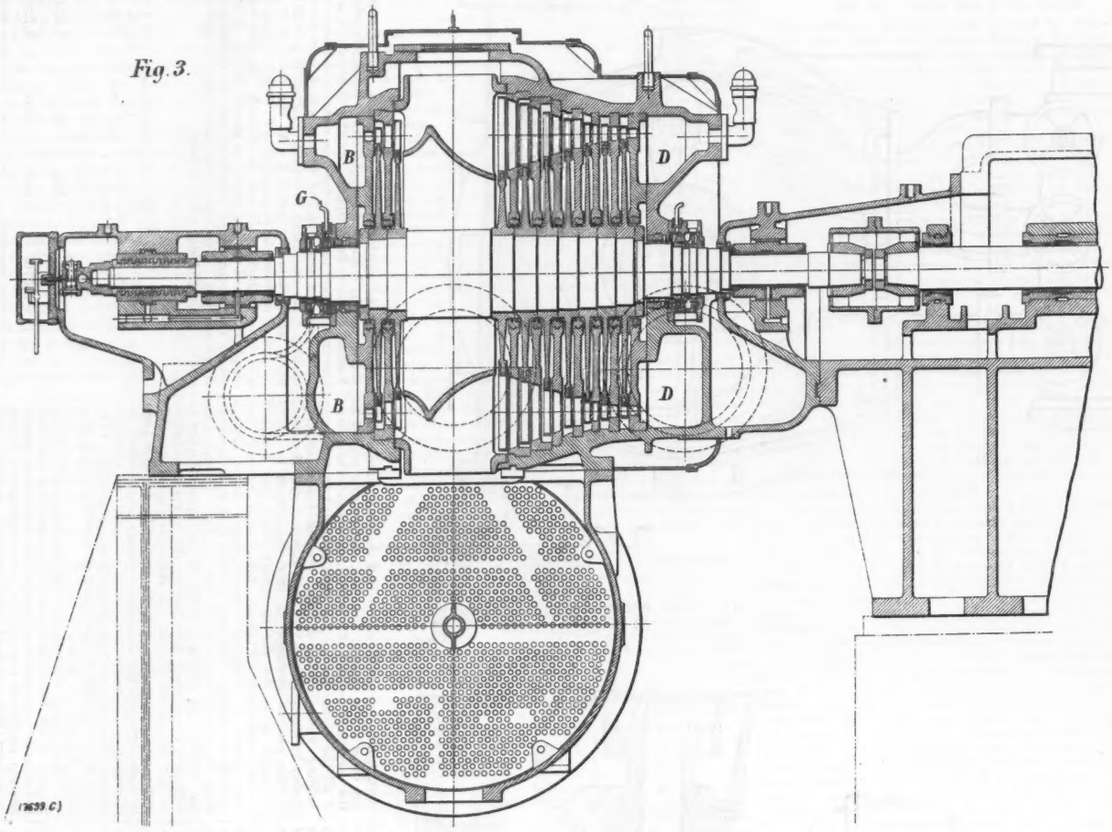
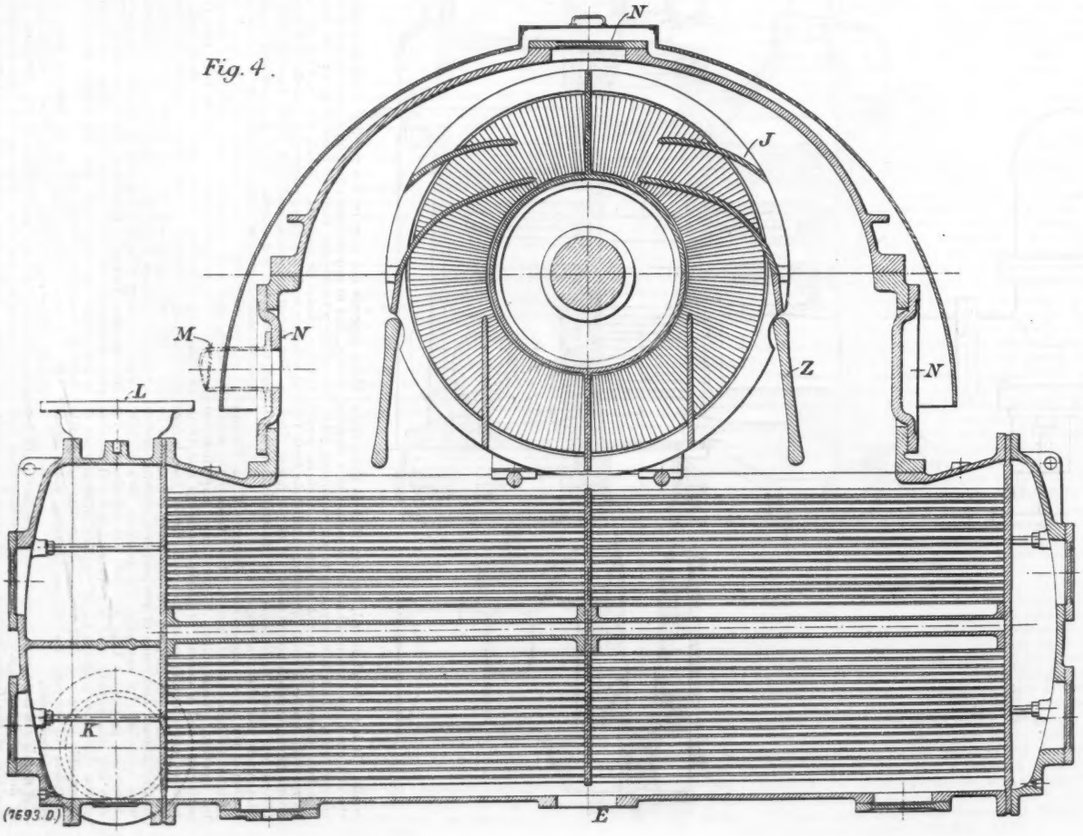


Fig. 4.



fastening and, in addition, show that with the riveted fastening it is possible to calculate the critical speed very closely.

In choosing a material suitable for turbine blading several considerations have to be borne in mind. High ultimate tensile strength and elastic limit are of first importance, because, if the turbine dimensions are to be kept within reasonable limits the centrifugal stresses in the blades are considerable. It is not, however, sufficient to know the mechanical properties of the material at ordinary temperatures only. One must be sure that the strength of the material is maintained when operating at high temperatures, and is not permanently affected by repeated changes in temperature. Numerous tests have been carried out by different experimenters on the strength of materials with varying temperatures. In a paper contributed to the Paris Meeting of the Institution of Mechanical Engineers in June, 1922, results of tests carried out by Professor F. C. Lea* are given, which confirm the general results. From these it is apparent that the ordinary carbon and alloyed steels suffer only negligible decrease in strength at the maximum temperatures with which turbine blades are called upon to deal. The case is, however, very different with bronzes, and Professor Lea shows the results of tests carried out on bronzes of five different compositions. In the case of a manganese bronze the ultimate tensile strength at 15 deg. C. is given as 35·7 tons/sq. in., this being in the neighbourhood of the figure obtained with ordinary carbon steels. At 300 deg. C., however, the ultimate tensile strength of this bronze is only 17·7 tons/sq. in. An aluminium bronze showed an ultimate tensile strength at 15 deg. C. of 37·48 tons/sq. in., and only 10·42 tons/sq. in. at 300 deg. C.

Metropolitan-Vickers have experimented for many years with such materials as have been produced which appeared to offer some promise as blading material. Brass, phosphor bronze and monel metal were found to erode more readily than 5 per cent. nickel steel, and the two former suffer from deterioration in physical properties when subjected for long periods to strain under varying temperatures. For general work under average conditions we have found 5 per cent. nickel steel, if suitably prepared, a very satisfactory material. It possesses a high ultimate tensile strength and elastic limit without being too hard to draw, and maintains its mechanical properties throughout the ranges of temperature likely to be met with in turbine practice. Tests extending over eight years have been carried out by Metropolitan-Vickers with blades constructed of rustless steel and iron. These materials have a chromium content of 13 per cent. to 14 per cent., and while they do not yet possess every desirable quality, they appear to have in a large degree the property of resisting corrosion and erosion. Unfortunately, in order to obtain the best results from rustless steel, the material must be in a hardened condition, and since it is not practicable to heat-treat the blades after machining, the steel should be hardened before machining. This, however, results in material which is too hard to draw and work readily with ordinary machine tools, and, in consequence, steel makers have recently concentrated on the production of rustless iron. This material closely resembles rustless steel except that it has a very low carbon content. It is claimed that rustless iron can be produced having similar anti-corrosive properties to that possessed by rustless steel, without being abnormally hard. At the present time, Metropolitan-Vickers have blades of one or other of these two materials in some 30 turbines.

An important feature of the Metropolitan-Vickers turbine is the design of the turbine spindle gland. One of these glands is illustrated in Fig. 10. It will be seen that it is arranged for operation either on steam sealing or water sealing. Normally, the turbine operates with a water seal. Water is supplied by means of the passage A to the periphery of the paddle wheel. The rotation of the paddle produces a centrifugal force at the periphery, and it is necessary to supply the water under a certain head. In practice this head may vary from 5 ft. to 25 ft. The centrifugal forces exerted on the water tends to maintain an equal length of water leg on each side of the paddle, but the difference in pressure between the inside and outside of the cylinder forces the water up the face of the paddle on the high-pressure side until equilibrium

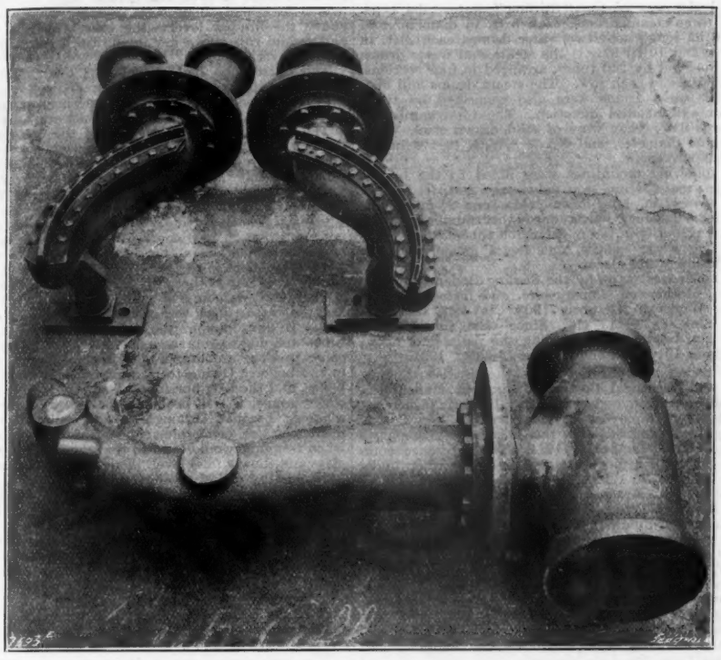
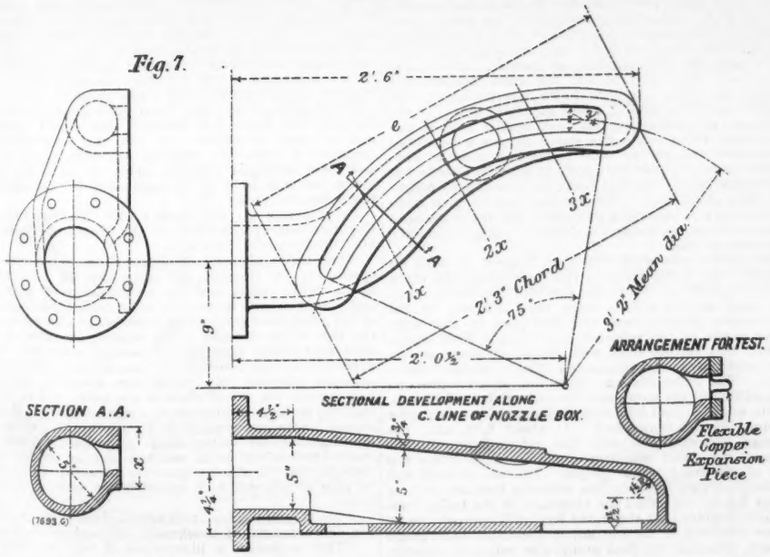


FIG. 5.



Change in Chord e.

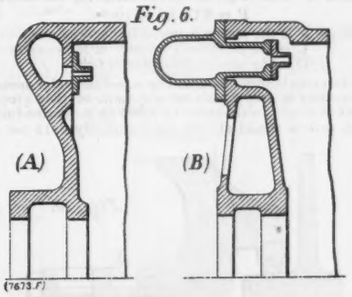
Pressure p Lb./Sq.In.	0	100	200	300	400	500
Inc. e in.	0	0·002	0·005	0·006	0·009	0·012

Increase in x.

Pressure p Lb./Sq.In.	Distance x Measured in Inches at		
	1	2	3
0	0·33	0·33	0·33
200	0·332	0·342	0·33
300	0·337	0·349	0·334
400	0·345	0·362	0·337
500	0·351	0·372	0·342
0	0·33	0·334	0·33
Max. def. in.	0·021	0·042	0·012

* See ENGINEERING, Vol. CXIII, pages 806, 829.

Fig. 6.



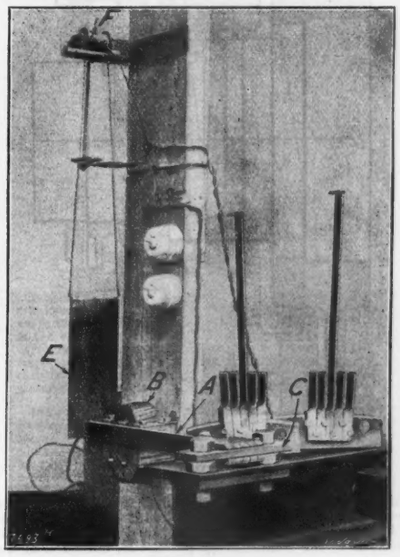


FIG. 8.

Fig. 9.

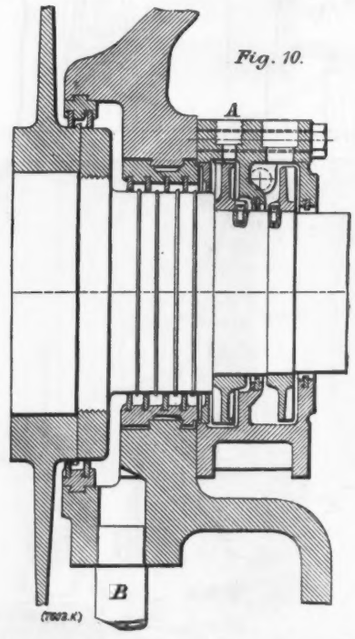
is produced. Under normal conditions a considerable portion of the outer face of the paddle is, therefore, not in contact with water. Experiments have been carried out on water paddles operating under a difference of pressure corresponding to that existing under service conditions, and also on water paddles wholly immersed in water. These experiments have shown that the power absorbed in rotating a paddle under operating conditions is considerably less than that required to rotate a paddle completely immersed and enclosed in a casing, at the same peripheral velocity. The work done in rotating a paddle in water is given by the following formula :—

$$P = 6\,U^3\,D^2 \times 10^{-6}$$

where P is the power required in horse-power,
U is the peripheral velocity in ft./second,
D is the outside diameter in feet.

The actual power absorbed by a paddle under operating conditions is only about 50 per cent. of that given by this formula. In the case of a 3,000 s.h.p. marine turbine, each paddle would absorb approximately 0·15 per cent.

Fig. 10.



of the power developed in the turbine. The quantity of water required would be approximately 1½ per cent. of the total condensate. This water is not lost, but returns to the condenser by passage B, indicated in the figure.

The paddles are designed so that a water seal is formed at approximately one-third of the normal running speed. For lower speeds steam sealing is resorted to, and the design of the gland is such that steam and water can both be on at the same time. It is customary, when leaving port or when manœuvring, to work on steam seal, water sealing being resorted to as soon as the ship is on its normal course. When this gland is working under water-sealed conditions no steam is blown into the engine room. This, while presenting a cleaner appearance than with steam-sealed glands, has the very important advantage that steam cannot escape into the turbine pedestals, and the possibility of this mixing with the oil and causing emulsification is eliminated. In none of the vessels fitted with this gland have any emulsification troubles been experienced. As a result of the absence of steam blowing into the engine room, repeated observations in hot climates have shown that water sealing results in a cooler engine room than when steam sealing is adopted.

(To be continued.)

Bright, Turned Bars.—We are informed that bright steel bars of a quality similar to those produced in the normalised black state are being manufactured by the British Rolling Mills, Limited, Birmingham, whose new factory, on the site of the old Barrow's Iron Works, Tipton, Staffordshire, has been specially arranged for the purpose. The firm has much reduced the cost of turning by the introduction of a machine which turns the bars at an unusually high speed and with extreme accuracy. The bars, which are supplied under the trade name of "Brymill," are circular in section and are guaranteed to be within 0·001 in. of any specified diameter between the limits of 1¼ in. and 4½ in. Bars with these qualifications can be made from any machine-able steel, whether mild, high carbon, or stainless, the price of turning varying according to the material. Careful attention is directed to special case-hardening steels and line shafting. The brightness and regularity of surface, superior to any finish obtainable by cold drawing, is imparted to the bars solely by the machining and without the use of acids. There is therefore no pitting of the metal. The plant includes, in addition to the turning machines, straightening rolls and a straightening press.

EXPLOSION OF A "STIRLING" WATER-TUBE BOILER.

A preliminary inquiry has been made by the Board of Trade, under the provisions of the Boiler Explosions Acts, 1882 and 1890, with regard to the cause and circumstances attending the explosion of a water-tube boiler which occurred at the Heaton Works of Messrs. C. A. Parsons and Co., Limited, Newcastle-on-Tyne, on August 8 last. Fortunately no one was injured by the explosion.

The boiler was of the "Stirling" water-tube type, having three steam drums, each 3 ft. in diameter and 10 ft. 6 in. long; and two water drums, each 3 ft. in diameter and 10 ft. long. The steam and water drums were connected by 240 tubes, arranged in four sections, with 15 tubes in each row. The steam drums and likewise the water drums were also connected by tubes fitted in a horizontal direction. The total number of tubes was 316; they were of solid drawn steel, 3½ in. in external diameter, and No. 7 S.W.G. (0·176 in.) in thickness when new.

The following mountings were fitted to the boiler: One 5-in. main steam stop valve, one 2-in. feed check valve, two 1¼-in. blow-down cocks, one 2½-in. double spring-loaded safety valve, one 1½-in. auxiliary steam stop valve, one ¾-in. stop valve for tube-cleaning purposes, two water gauges, one steam gauge, and one high-and-low water alarm.

The boiler was made by the Stirling Boiler Company, Limited, Motherwell, Lanarkshire, and installed in the Heaton Works in October, 1903. It was, therefore, nearly nineteen years old. Since that time various repairs had been made, including the renewal of about 30 tubes in 1916, and one tube in January, 1921.

The boiler was insured with the British Engine, Boiler and Electrical Company, Limited, Manchester, and had been examined periodically by their inspectors, and also by employees of the owners. It was last thoroughly examined by the insurance company's inspector on December 5, 1921. The insurance company's inspector again examined the boiler when under steam, on June 14, 1922.

In his report, Mr. J. H. Atherton, engineer-surveyor to the Board of Trade, states that the boiler in question was one of four different types used for generating steam for the purpose of testing turbine machinery and running the air compressor engine and steam hammer in the owners' works, and was known as "Number 4." The boiler was designed for a working pressure of 350 lb. per square inch, but was generally worked at pressures varying from 100 lb. to 240 lb. per square inch. The feed water used was the condensed steam from the turbines and auxiliary engines in the works, supplemented by water from the town's supply when required, and was passed through a feed heater on its way to the boiler. No filter was fitted. Whilst at work, the boiler was blown down once every other day by the boiler foreman, each time the water being lowered in the gauge glass about 3 in., the intention being to get rid of any sediment that might be contained in the supplementary feed water and to keep the boiler as clean as possible. It was also the practice thoroughly to test the water gauges twice in every 12 hours when the boiler was working under normal conditions, that is, when supplying steam to the machinery in the works; but when special tests of turbines were being made the water gauges were tested much more frequently. The boiler had been in continuous use, except for short periods, since its installation in October, 1903. It had been the practice to empty the boiler about every three months, and to open it up for cleaning and inspection purposes; but in this instance it had not been opened up for cleaning or inspection since December 5, 1921.

The boiler was shut down on August 5, and on August 7 the boiler foreman ran water from the town supply through the feed pipe line into the boiler, until the water showed a little more than half-way up the front water gauge glasses and half-glass in the other water gauge of the reflector type on the back steam drum; this corresponded with 12 in. of water in the front and centre steam drums and 15 in. in the back steam drum. The boiler fire was lighted at about 5 a.m. on August 8, and the stop valve opened at about 7.10 a.m. Steam was then used for the steam hammer and the engine driving the air compressor. At about 8.30 a.m., the fireman reported sick and was relieved by another fireman, the water was then above the level of the top nut of the front water gauges. The water level was verified, at that time, by the relieving fireman, and, at about 9 a.m., he called the attention of the boiler foreman to the fact that the water level still appeared to be above the level of the top nut of the front water gauge glasses, although the feed pump was only just moving. The boiler foreman then thoroughly tested the water gauge, and seeing water rushing up the glass he formed the opinion that the boiler was priming through the water level being too high. Just about that time a signal had been given from the test-house that steam was being turned on to a set of turbines which were being tested; the steam pressure shown on the pressure gauge was about 110 lb. per square inch. The boiler foreman then proceeded to open the blow-down cock on the centre water drum, and water was blown from the boiler for about 1½ minutes; immediately after the blow-down cock was shut, the high-and-low water alarm commenced to whistle. The boiler foreman again tested the front water gauge and found that the boiler was still priming, and, as he was uncertain as to whether the water was too high or too low, he ordered the fireman to stop the grate and increase the speed of the feed pump, and then he shut the boiler stop valve with the intention of trying to stop the priming. He had just returned from the top of the boiler when the explosion took place. Immediately prior to the explosion the fireman could not get the feed pump to work faster as instructed, because the steam pressure had dropped to about 50 lb. per square inch; so he was preparing to draw the fires.

Continuing his report, Mr. Atherton states that on visiting the works after the explosion he found that the burst tube, together with two others in the front row of tubes connecting the front steam and water drums, had been cut out and new tubes were being fitted, and that the scale and sediment had been cleaned out of the steam and water drums. The three tubes removed from the boiler showed considerable signs of overheating over a length of about 5 ft., starting from about 3 ft. above the fire-bar level; the other tubes in the first and second row and a few in the third row also showed signs of overheating.

The burst tube had opened out over a distance of 8 in. The thickness of the tube on the side opposite to the ruptured portion was 0·12 in., tapering away gradually to the line of fracture, where the thickness was 0·04 in. The two tubes from each side of the one that failed did not show any signs of corrosion when sectioned, but Mr. Atherton found about ¼ in. of scale inside. The remaining tubes in the boiler had a large amount of scale deposited in them; the thickness of the scale varied from ⅛ in. in the front section of tubes to fully ¼ in. in the back section. From the evidence taken, it appeared that there was a depth of from 6 in. to 8 in. of sediment and scale in the two water drums and about 3 in. of sediment in the back steam drum round the ends of the tubes; the other two steam drums also contained a considerable amount of sediment. Mr. Atherton states that the water gauges were clear at the time of his examination. In his opinion, the primary overheating of the tubes was due to shortness of water, but a contributory cause was the amount of scale and sediment deposited in the boiler. Owing to the amount of sediment in the boiler, and the long horizontal length of pipe to the front water gauge, it was probable the water gauge was not reliable; because, although the soft sediment would not prevent water being blown out from the water gauge when tested, it would tend to trap the water in the gauge glass and show a false level. This opinion appeared to be confirmed by one of the firemen, who stated that sometimes he had seen the front water gauge showing a full glass of water when none at all was showing in the back water gauge glass.

The sudden drop in pressure, when the steam was turned on to the turbine, appeared to have caused the boiler to prime, and it was at the same time that water was being blown out from the boiler, consequently the water level would be lowered very rapidly.

Had the boiler been cleaned in accordance with the usual practice the explosion would probably have been avoided, although the tube that failed was weak.

The test-house foreman stated that he was in full charge of the boilers and that he had to supply steam for turbine tests when required by the works manager; he also stated that he had mentioned to the assistant works manager, on several occasions, that the boiler was overdue for cleaning, but that he had invariably received the answer that it would have to wait until certain turbine tests had been carried out; he further stated that he did not think it was his duty to open a boiler out without the approval of the works manager.

There appears to have been considerable confusion between the test-house foreman, the works manager and the clerk of works as to who was responsible for laying-off a boiler for cleaning purposes, but this has now been arranged, and the clerk of works has been instructed that he is to be responsible for the whole of the boilers in future.

In summing up the inquiry, Mr. Thomas Carlton, Engineer Surveyor-in-Chief to the Board of Trade, in his "Observations" states :—

"This boiler, although in almost constant use, was not opened up for cleaning and inspection for a period of about eight months, and the accumulation of sediment and scale was such apparently as to impair the reliability of the glass water gauges, and therefore to increase unduly the risk of overheating. The wasted condition of the tube that failed through overheating when the boiler pressure was very much lower than the ordinary working pressure indicates that greater care should be exercised to ascertain the actual state of the tubes and to ensure that the boiler is maintained in a safe condition. Having regard to the uncertainty as to whether the whistle of the high-and-low water alarm gave warning that the water level in the boiler was too high or too low, it is thought that the alarm might with advantage be modified to give a different and unmistakable warning in each case.

"The thinning of the burst tube and the form of rupture are characteristic of overheating through scale deposit.

"This explosion is illustrative of the necessity for the systematic cleaning and inspection of boilers of this type at short intervals; these are matters of first importance which should not be subordinated to any other consideration.

"It is very fortunate that no person was injured by the explosion."

Electric Ore Research and Ore Discoveries in Sweden.—Recent results throw a most favourable light upon the electrical method of research of ore deposits. Important investigations have been undertaken, and the work which is carried out at the expense of the State but is under the management of the Geological Society, will be continued on an extensive scale this year and in all likelihood for several years to come. It is more especially in the Västerbotten part of the country that research so far has been made, resulting in the discovery of rich copper ore deposits, at Bjurfors and at other places. Borings have fully confirmed the indications of important deposits by the electric research.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

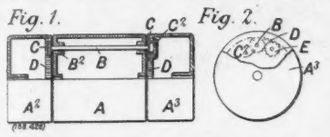
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AGRICULTURAL APPLIANCES.

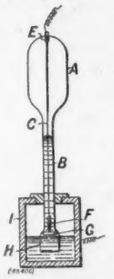
188,426. P. A. Poppe, Coventry, and White and Poppe, Limited, Coventry. Power-Driven Grass-Cutting Machines. (8 *Figs.*) August 27, 1921.—The invention relates to power-driven grass-cutting machines, tractors or other like vehicles of the kind in which the main driving wheel (*i.e.*, the road wheel) comprises three rollers arranged side by side coaxially, the centre one being the one through which the drive is transmitted to the road. According to the invention, the centre roller carries a member which works in conjunction with two side rollers and constitutes also a driving connection with them, adapted when the vehicle travels in a straight line automatically to lock all the rollers together as one, and when the vehicle swerves, permits independent rotation of the side rollers relatively



to the centre roller, the one forwarding and the other backwarding. The centre roller A serves as the carrier for the principal parts of the mechanism, and within it is provided a rotating shaft B parallel to the roller axis but offset therefrom. The shaft is supported in bearings B^2 carried by the roller A, and at the ends of it are provided pinions C, C^2. Around the interiors of the other rollers A^2, A^3 are provided internal gear teeth D, and one of these pinions C gears direct with the internal teeth on one roller and the other pinion C^2 gears with similar teeth on the other roller, through an intermediate or idler wheel E, the arrangement being such that the gear ratio is the same for each roller. The pinions C^2 and E are of extra length with a reduced part on the former enabling its teeth to clear the teeth D in the known manner. (*Accepted November* 22, 1922.)

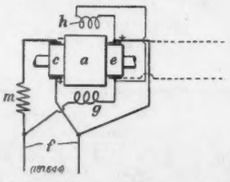
ELECTRICAL APPARATUS.

188,400. C. S. Agate, Chelmsford, and A. E. Hill, Chelmsford. Regulating Electric Currents. (1 *Fig.*) August 10, 1921.—The invention relates to means for regulating the strength of electric currents, and its principal object is to provide means whereby the strength of a current may be kept constant even though the voltage varies within wide limits. A is a bulb having a long neck B depending from it. C is an iron wire supported by a platinum rod of sufficient cross-section not to be heated appreciably by the passage of the working current. The platinum rod is sealed into the top of the bulb at E. The bottom of the wire C is connected through a spring F to a plug G fitting into an



enlargement H at the bottom of the neck B. The bulb and neck are filled with mercury and then inverted in a bath of mercury contained in an iron box I. Hydrogen is then allowed to pass up through the mercury and fill the bulb. The current to be regulated flows through the mercury of the bath, up through the mercury in the neck, and through the wire C and the platinum rod. To obtain constancy of current, the arrangement should be such that the exposed portion of the wire C should be on the verge of red heat in which condition it will absorb hydrogen, and its resistance will in consequence increase. (*Accepted November* 22, 1922.)

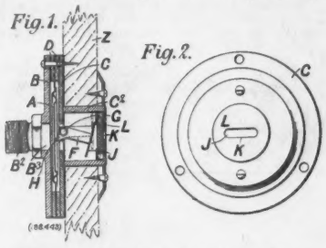
187,644. The Brush Electrical Engineering Company, Limited, Loughborough; B. A. M. Boyce, Loughborough, and P. Huggins, Loughborough. Dynamo-Electric Machinery. (3 *Figs.*) May 7, 1921.—For use in electric welding,



a plant, in accordance with this invention, embodies a generator that comprises a compound series and shunt field system and an armature having a winding for which a circuit is at all times completed from one welding lead to the other so as to exclude the series coil or coils of the field system and thus provide a substantially non-inductive path across the leads. The machine comprises a field system associated with an armature *a* having two windings and two commutators, each winding being connected to a separate commutator. The brushes of one commutator *c* are coupled, in parallel with the brushes of the other commutator *e*, to the leads *f* supplying the welder, series excitation being provided for by a winding *g* in the circuit of only one of the armature windings, a non-inductive resistance *m* to balance the ohmic resistance of the series winding *g* being inserted in the circuit of the armature winding, and the shunt winding *h* being conveniently excited from that side of the system which supplies current through the series winding. (*Sealed.*)

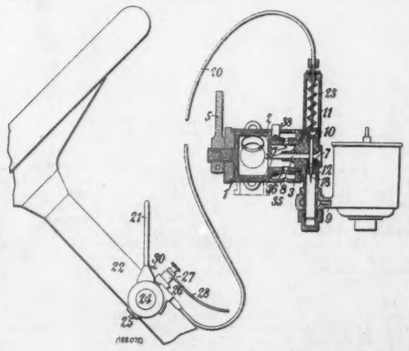
GAS ENGINES, PRODUCERS, HOLDERS, &c.

188,443. Humber, Limited, Stoke, Coventry; J. A. Cole, Stoke, Coventry, and E. M. Powell, Stoke, Coventry. Indicators. (3 *Figs.*) September 7, 1921.—The invention relates to indicators for automatically giving indications of a fluid pressure, applicable, *inter alia*, to pressure operated systems for circulating lubricant upon engines, of the type in which the fluid acts upon a diaphragm which actuates the short end of a pivoted lever. According to the invention, the short end of the lever directly engages the diaphragm and the long end directly carries an indicating member, such as a plate, part of which appears behind a window, or a stem which is adapted to project or lie concealed, according to the position of the lever and diaphragm. The flexible diaphragm A is mounted between two plates B, C, which are spaced apart by washers D to provide room for a limited movement of the diaphragm. Centrally disposed upon the plate B is a spigot B^2 to form a connection with the lubrication system, a hole B^3 extending through the plate to bring the lubricant into contact with the diaphragm. Upon the other plate is a central tubular extension C^2 adapted to extend



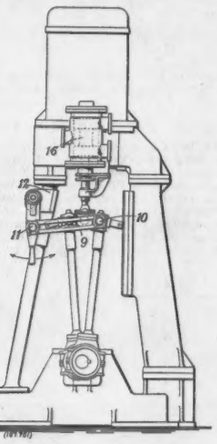
through the dashboard Z of a motor vehicle and to contain the indicating device. Within the tubular extension is a lever F which is pivoted adjacent to the diaphragm about a horizontal axis G parallel with its face and conveniently arranged slightly above its centre. The short end H of this lever is carried back to the face of the diaphragm, thus constituting a form of bell crank lever adapted to multiply the movements of the diaphragm. The longer end F carries in a plane transverse to its length a plate J at its free end, and the upper half of this plate conveniently is painted red and the lower half is white. When the diaphragm is in the normal position with no pressure acting upon it, the plate J is at its lowest position and the upper half of it is opposite a narrow horizontal slit K formed in a plate L which closes the front end of the tubular extension C^2. When the lubricant pressure acts upon the diaphragm, the latter is deformed and acts to tilt the lever and raise the plate J so that the portion painted white is then brought opposite to the slit K, and it is then evident that the lubricant is circulating. (*Accepted November* 22, 1922.)

188,072. H. J. Stroud, Bromham, near Bedford. Carburettors and Ignition Control Devices. (1 *Fig.*) August 2, 1921.—The invention relates to carburettors and ignition control devices for internal-combustion engines. According to the invention, means are provided whereby the chauffeur can at will, from his seat and quite independently of any throttle valve control, and at all speeds of the engine, regulate, control or instantaneously cut off the delivery or supply of liquid fuel to the engine, the means being connected by Bowden wire transmission mechanism, to a handle within easy reach of the chauffeur. Control means may also be provided whereby, at the same time as petrol is cut off, the ignition system may be cut out or interrupted, thus preventing any danger of back-firing. 1 is the main body of the carburettor in which is arranged the throttle valve 2. 3 is the jet body attached to the main body 1. The throttle



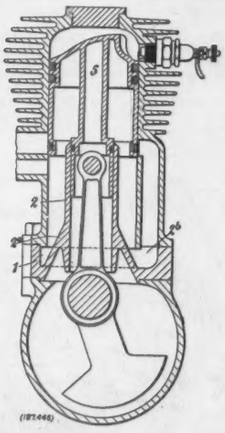
valve 2 is operated by a throttle lever 5. The jet or fuel orifice 7 is disposed in the jet body 3 and delivers fuel into a branch passage 8 formed in the jet body 3. Primarily air is admitted through the branch passage 8 and the openings 35, 36, 37 and 38. The jet body 3 is provided with an extension 10 on to which is screwed a tubular casing 11. Diametrically opposite the extension 10 on the jet body 3 is a tubular portion 12 having a reduced end adapted to be connected to the branch 9 projecting from the float feed casing. 18 is a needle valve having an enlarged upper end disposed in the extension 10. The enlarged upper end of the needle valve 18 is connected by a Bowden wire 20 to an operating handle 21 on the steering column 22, the handle 21 being within easy reach of the chauffeur. The flexible connection 20 is operated against the action of a spring 23 disposed in the tubular casing 11. The handle 21 is mounted on a pin 24 carried by a clip 25, secured to the steering column 22. The clip 25 also carries an insulating block 26 having a contact terminal 27 from which a lead 28 is taken to the ignition system. On the handle 21 is provided a projection 30 so that at the same time as petrol is entirely cut off by the action of the handle 21 (which is earthed through the chassis) operating the needle valve 18 to close the outlet from the fuel orifice in the branch passage 8, contact is made between the projection 30 on the handle 21, and the contact terminal 27, thereby cutting out the ignition system. The handle 21 is so arranged in relation to the needle valve 18 that, before fuel can be admitted, the needle valve 18 must be lifted a certain amount, after which the tapered portion of the needle valve controls the fuel orifice, the object being to leave the ignition switched in and so prevent plugs oiling up. (*Sealed.*)

187,761. T. B. Cooper, Dundee, and N. R. Cooper, Dundee. Internal-Combustion Engines. (8 *Figs.*) November 15, 1921.—The invention has reference to internal-combustion engines of the Diesel or semi-Diesel type, and has relation to the starting and reversing gear of such engines that comprises a pilot valve 16 connected with an air bottle and with the cylinders, either directly or through the intermediary of the ordinary air



admission valves, and Stephenson link motion actuated from the crankshaft of the engine for controlling and operating the pilot valve 16. In accordance with the invention, the lifting link 9 of the valve gear is in duplicate on opposite sides of the die-carrying link, and is mounted at its ends on pins 10, 11 respectively, that extend laterally from both sides of the die carrying link and the operating lever, the latter being pivotally mounted on a bracket 12 on the engine standards. (*Sealed.*)

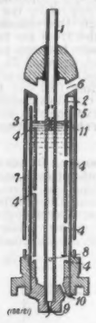
187,446. D. Scott, Glasgow. Internal-Combustion Engines. (2 *Figs.*) October 18, 1921.—The invention relates to two-stroke cycle internal-combustion engines. The invention consists of a two-stroke internal-combustion engine with an initial compression space separate from the crank chamber and formed by a member disposed between the piston and the crank chamber, said member also constituting a crosshead guide for the engine connecting rod. The characteristic feature of the



invention resides in the fact that the initially compressed charge is expelled from the compression space at the bottom of the guide member, the latter being shaped to assist the transference. To enable this result to be obtained, the guide member consists of a cylindrical portion 2, in which the piston extension 5 slides, and a bottom flange 1 so connected therewith by an integral conical portion 2*a* as to provide an annular cavity 2*b* at the base of the member leading to the transfer passage. (*Sealed.*)

188,121. E. L. M. Emtage, London. Carburettors. (1 *Fig.*) August 30, 1921.—The invention relates to carburettors of the type comprising concentric slow-running and main or power jet tubes. 1 is the slow-running jet tube, 2 the diffuser tube surrounding the slow-running jet tube, 3 the guard tube surrounding the diffuser tube, which is orificed as at 4 below the lip 5 of the guard tube. 6 are the main or power jet orifices, and 7 is an outer air tube. According to the invention, the slow-running jet tube is formed with a fuel series-feed hole (or holes) 8 level or above or below the lowest orifice 4 in the diffuser tube, and above the level or levels of the fuel parallel-feed holes 9, 10 respectively in the slow-running jet tube and in the diffuser tube, and supplied

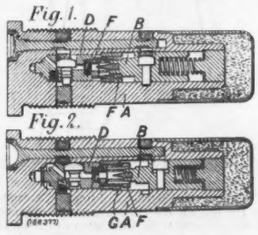
direct from the carburettor float chamber or reservoir. The feed hole 10 constitutes the submerged main or power jet. The size of the series feed hole 8 in the slow-running jet tube may



conveniently be the same as that or larger, or smaller than that of the slow-running jet orifice 11 higher up in the slow-running jet tube. (*Sealed.*)

GUNS AND EXPLOSIVES.

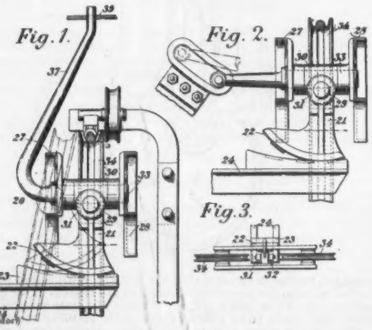
188,377. Sir W. G. Armstrong, Whitworth and Co., Limited. Newcastle-upon-Tyne, and H. G. Taylor, Newcastle-upon-Tyne. Percussion Fuses. (3 *Figs.*) August 4, 1921.—The invention relates to a base fuse of the type in which there are two pellets, one carrying a needle and the other a detonator, the two pellets being kept apart during retardation due to impact and passage through an armour plate or other obstruction, and being brought together to fire the fuse after such retardation. According to the invention, the pellets B, D are kept



apart during flight by means of springs F carried by the pellet D and normally butting against the pellet B and restrained from outward movement by a tube G screwed in the body A. When the two pellets B, D move forward together owing to their momentum, on the retardation of the projectile, the springs F pass beyond the tube G (see Fig. 2) and are therefore able to expand so that after the retardation due to impact passage through the obstruction, the pellets can be brought together to fire. *Accepted November* 22, 1922.)

LIFTING AND HAULING APPLIANCES.

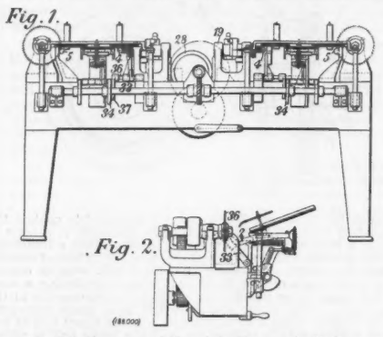
188,047. H. F. H. Shields, Welling, and The British Ropeway Engineering Company, Limited, London. Aerial Ropeways. (3 *Figs.*) July 28, 1921.—The invention relates to aerial ropeways. According to the invention, there is provided in or for an aerial ropeway, a rope supporting mounting in which the rope-carrier, such as a sheave or sheaves 34, or a saddle, is arranged to align itself to the angular pull of the rope. The mounting is characterised by the rope-carrier or a sheave beam therefor being carried by a universal joint which is supported from beneath, and by such support being arranged to rock or roll and being so guided that the rope-carrying portion of the rope-carrier swings in a path which is part of a curve having its centre above the rope. A self-aligning mounting designated generally by 20, comprises a bearing pedestal 21 having a cylindrically-curved base 22 arranged to roll on a cylindrically-curved bearing 23 that is fixed on a horizontal



beam 24 extending laterally from a trestle head. The radius of curvature of the base 22 is smaller than that of the bearing 23, and these parts are so disposed that the pedestal can roll on its base towards and away from the trestle. A sheave beam comprises two channelled bars 27, 28 mounted by means of a universal joint on the pedestal 21. The one axis of this universal joint is constituted by two trunnions 29 of a sleeve 30 journalled in bearings 31, 32 formed in the forked upper end of the pedestal 21, and the axis at right angles thereto is constituted by a spindle 33 that extends through the sleeve 30 and carries the bars 27, 28. Two sheaves 34 for carrying the rope are mounted one at either end of the sheave beam. In order to guide the sheave beam so that the parts of the sheaves on which the rope rests shall swing in a path which is part of a curve having its centre above the rope, so that the mounting shall always tend to take up a position of equilibrium, a steadying arm 37 is provided. As shown in Fig. 1, this arm is integral with the spindle 33 and has the form of an opened-sided stirrup, whereof the lower horizontal part is constituted by the spindle 33, whilst its upper vertical part extends through and is guided in a hole in a plate 39 which projects horizontally from the trestle head vertically above the beam 24. The hole, wherein some play may be provided for the arm 37 if desired, is situated vertically above the centre of support of the mounting when the latter is vertical, and the centre of curvature of the bearing 23 is preferably situated in this hole, whilst the centre of curvature of the base 22 of the pedestal 21 is preferably situated in the axis of the trunnions 29. Both the base of the pedestal 21 and the bearing 23 are extended laterally towards the trestle and away from the vertical centre line of the mounting, so that whenever the pedestal rolls on its bearing towards the trestle its centre of support will still remain on the bearing. Owing to the arm 37 extending through the hole in the plate 39, the described self-aligning mounting is positively retained in a position of neutral equilibrium. When the mounting is erected at the other side of the trestle it will be appreciated that this arrangement will be modified accordingly. (*Sealed.*)

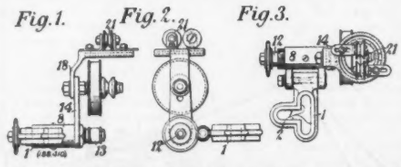
MACHINE AND OTHER TOOLS, SHAFTING, &c.

188,000. S. H. Fell, Windermere. Slot Cutting Machine. (5 *Figs.*) April 22, 1921.—The invention relates to a machine for cutting slots in the end of a wooden tube. According to the invention, tubes to be nicked are fed by hand, but preferably automatically, along a chute to a holder comprising a movable chuck element and a back spindle or pilot, which latter is slotted or grooved to allow the passage of the slotting element, such as a circular saw. The headstock spindle or chuck engaging the bobbin is adapted to be rotated intermittently through 90 deg., so that, before leaving the machine, the tube is nicked twice or four times at right angles to one another to form a cruciform cut in the end of the tube. A bobbin is fed along the fingers 2 until it lies in line between the movable spindle 4 and the fixed split spindle 5. The cam 28 then moves up the headstock 19 to force the wooden bobbin over the spindle 4 to be



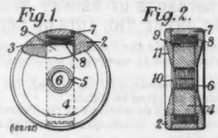
gripped by fins thereon and then into the saw teeth to a predetermined distance. The bobbin is then returned a distance sufficient to allow it to clear the teeth of the saw, and is prevented from falling out between the spindles 4, 5, by the fins on the spindle 4. The bobbin is then turned through one quarter revolution by the operation of ratchet-feeding mechanism, and receives another slotting operation by means of the saw. The bobbin is ejected from between the spindles 4, 5 by an arm 33 on a shaft 36, to which is fastened an arm 37. The arm 33 normally lies between the fins and the headstock 19, and is moved axially by means of a face cam 34 on the shaft 9 moving against the arm 37 and sliding the shaft 36 axially. It will be seen in the machine shown, the parts are duplicated to be operated from a cam 28, being arranged so that as one headstock is receding, the other one is advancing. (*Sealed.*)

188,410. J. B. Wade, Oldham, and F. Jagger, Oldham. Grinding, Milling and Knurling Attachments. (5 *Figs.*) August 16, 1921.—The invention relates to grinding, milling, knurling and similar attachments for use on machine tools. According to the invention, the attachment comprises a bracket 8 carrying a grinding, milling, knurling or the like spindle 12 and hinged directly to a bracket 1 so as to turn on an axis which is substantially parallel with the spindle 12, the bracket 1 being provided with a tee or cross-shaped slot 2 adapted to be engaged



by the tool post of the machine tool. The hinge connecting the brackets 1, 8 is provided with means whereby it can be retained in any position, and the spindle 12 is provided with one or more pulleys 13. The invention further consists in the provision on the bracket 8 of a bracket 14 angularly adjustable thereon and having arms 18 carrying jockey pulleys 21. The arms 18 are adjustable in three directions and as a consequence the jockey pulleys can be fixed in any position to guide the driving rope employed in connection with the pulleys 13. (*Accepted November* 22, 1922.)

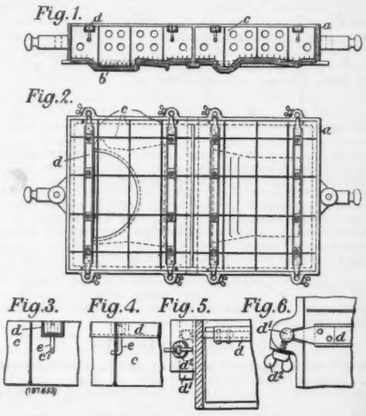
188,182. Coventry Gauge and Tool Company, Limited, Coventry; H. H. Harley, Coventry; H. Barker, Coventry, and A. Hewitt, Coventry. Engineers' Ring Gauges. (8 *Figs.*) October 21, 1921.—The invention relates to ring-thread and plain ring gauges as used by engineers for testing the accuracy of external screw threads and diameters. A ring gauge constructed according to the invention is characterised in that the gauge hole is formed by the adjacent ends of a number of fixed gauge members, one or more of which is or are capable of adjustment for wear towards the axis of the gauge hole. Adjustment for wear is made by grinding down the abutting portions of the said adjacent ends of the gauge members and subsequently relapping the gauge when assembled. The body 2 of the gauge, which is of circular disc shape, has a diametric bore 3 to receive the gauge members 4, the inner ends 5 of which are semi-circularly recessed and screw threaded. The abutting surfaces of the inner ends 5 are carefully ground so that when the two gauge members are in contact a complete screw thread gauge hole 6 is formed between their ends. The outer ends 7 of the diametric bore 3, which may be of non-circular cross-section are enlarged and tapped to receive locking screws 8 which are adapted to take a bearing upon the outer ends 9 of the gauge members 4. The body 2 of the gauge is formed with an axial hole 10 of slightly larger diameter than the gauge hole 6 formed



by the inner ends of the gauge members. The various parts of the gauge are suitably hardened and when assembled the gauge hole is lapped to size. In order to enable the gauge to be used on the work close up against a collar or the like the gauge may, as shown in Fig. 2, be dished on one or both faces 11. (*Sealed.*)

MINING, METALLURGY AND METAL-WORKING.

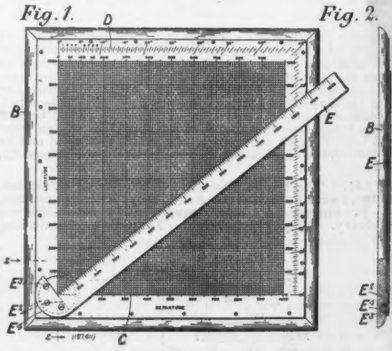
187,653. G. C. Bingham, Maldon. Moulding Flask. (17 *Figs.*) March 14, 1922.—The invention relates to moulding flasks of the stayed type. The invention consists in forming the stays independently of the flask in such manner that the stays may be raised and so held while the flask is being filled with sand, and then released and allowed to jar down with the sand during the actual ramming, after which the whole may be firmly secured together to allow of the mould being lifted off the pattern or turned over with the pattern and the latter then lifted off in the usual manner. The flask *a* fits on to the moulding plate *b* in the usual manner, but the transverse and longitudinal stays *c*, instead of being directly connected with the flask as heretofore, are connected together in two clusters to suit the patterns being moulded, and each of the clusters is connected with cross bars *d*,



the ends of which fit guides in the flask so that the clusters of stays may be raised or allowed to fall evenly in the flask and be held as desired. A convenient method of connecting the cross bars *d* with the stays is shown in Figs. 3 and 4, and consists of a number of rods *e*, the lower ends of which are hooked to engage holes e^1 in the stays *c*, while their upper ends pass through holes in the cross bars *d* and are screw-threaded to receive a securing nut. For guiding the ends of the cross bars *d* and fixing them as desired, the method shown in Figs. 5 and 6 is employed. This consists of rods d^1, one of which is secured by a ball and a socket joint to each end of each cross-bar, and is adapted to slide vertically in a socket on the exterior of the flask and fitted with a set screw d^2 by means of which it may be fixed as desired. (*Accepted November* 8, 1922.)

MISCELLANEOUS.

187,411. C. F. Linton, Streatham Hill. Subdivided and Graduated Charts. (2 *Figs.*) April 27, 1922.—The invention relates to subdivided and graduated charts or plates and scales for performing traverse table and similar calculations. According to the invention, such a device comprises a rectangular chart C divided into uniform squares, provided with a scale of angles D measured from one side of the chart about one end of that side as centre, mounted on a base board B. E is a straight edged



arm that is provided with or secured to a block E^2 of circular form. The block E^2 has a semi-circular portion in the plane of the chart C removed and fits into a circular hole in the base board B. The centre of the block is co-axial with the centre from which the scale of angles D is measured. The block has an integral flange E^3 engaging a recess on the underside of the base board B, and a separately attached flange E^4 at the upper side of the base board, for example, formed integral with the straight edged arm E. (*Accepted November* 1, 1922.)